FAIENCE AND GLASS BEADS FROM THE

LATE BRONZE AGE SHIPWRECK AT ULUBURUN

A Thesis

by

REBECCA SUZANNE INGRAM

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

May 2005

Major Subject: Anthropology

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Approved as to style and content by:

Cemal M. Pulak (Chair of Committee)	Shelley Wachsmann (Member)
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ABSTRACT

Faience and Glass Beads from the

Late Bronze Age Shipwreck at Uluburun. (May 2005)

Rebecca Suzanne Ingram, B.S., Biola University

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Beads are one of the earliest forms of ornamentation created by humans; prized during the Bronze Age for both their aesthetic as well as amuletic value, beads also served to signify the social status of the wearer. Beads functioned as an important trade commodity during the Late Bronze Age, as demonstrated by their abundance aboard the Uluburun shipwreck. This Late Bronze Age shipwreck, discovered off the Turkish coast at Uluburun in 1982, dates to approximately 1300 B.C. Thousands of beads of vitreous material were found on the shipwreck, including approximately 75,000 faience beads and 9,500 glass beads.

Bead form and style represented in the faience and glass beads at Uluburun are relatively simple and are quite common at archaeological sites throughout the Late Bronze Age Levant. Faience beads found at Uluburun vary widely in form and comprise eight distinct categories. While the surface glaze remains in rare patches only, most faience beads exhibit a blue undertone. Other colors, while less common, include red, yellow, white and turquoise. The glass beads found at Uluburun may be loosely grouped into two categories, small and large. Many of the large glass beads exhibit yellow and white spot or crumb decoration, or a combination of both, and there is a distinct

possibility that all the large glass beads were decorated in this way, but surface deterioration masks the decoration.

Many of the faience and glass bead categories represent items of cargo, as evidenced by a concreted lump of small glass beads transported inside a Canaanite jar. Other, less prolific, bead categories probably represent the personal belongings of the crew or passengers aboard the ship.

Beads found in archaeological contexts are notoriously difficult to date due to their extended use throughout generations; for this reason, the Uluburun beads represent an important contribution to the archaeological record and bead studies in particular, for the mere fact that they may be dated by provenance alone to the late 14^{th} century B.C.

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CHAPTER I

INTRODUCTION

The Bead Trade and the Uluburun Shipwreck

Beads are considered one of the first forms of ornamentation created by humans. Due to their durability, ease of transport, and widespread use, beads were already considered a valuable trade commodity in Neolithic societies and were composed of diverse forms and materials.[1] The trading of beads continued throughout millennia; from the 16th to 18th centuries, European merchants brought millions of Venetian glass beads to Africa, where the beads were traded for gold and slaves, consequently becoming a vital part of African economy and society.[2] Early European colonists in North America also recognized beads as both versatile and desirable articles of trade.[3]

That beads functioned as a trade commodity during the Bronze Age is confirmed by their abundance aboard the Uluburun shipwreck. This wreck, discovered off the southwest Turkish coast at Uluburun near Kaş in 1982 (fig. 1), was excavated over 11 consecutive summer seasons, from 1984 to 1994, by the Institute of Nautical Archaeology at Texas A&M University.[4] The range of artifacts recovered from the wreck suggest a date of around 1300 B.C.[5] and provide an unparalleled view of Late Bronze Age palatial or elite gift exchange.[6]

This thesis follows the style and format of the *American Journal of Archaeology*.

[1] Dubin 2004, 30.
[2] Dubin 2004, 132.
[3] Erikson 1993, 42.
[4] Pulak 1998, 188.
[5] Pulak 1998, 213-4.
[6] Pulak 2001, 48.

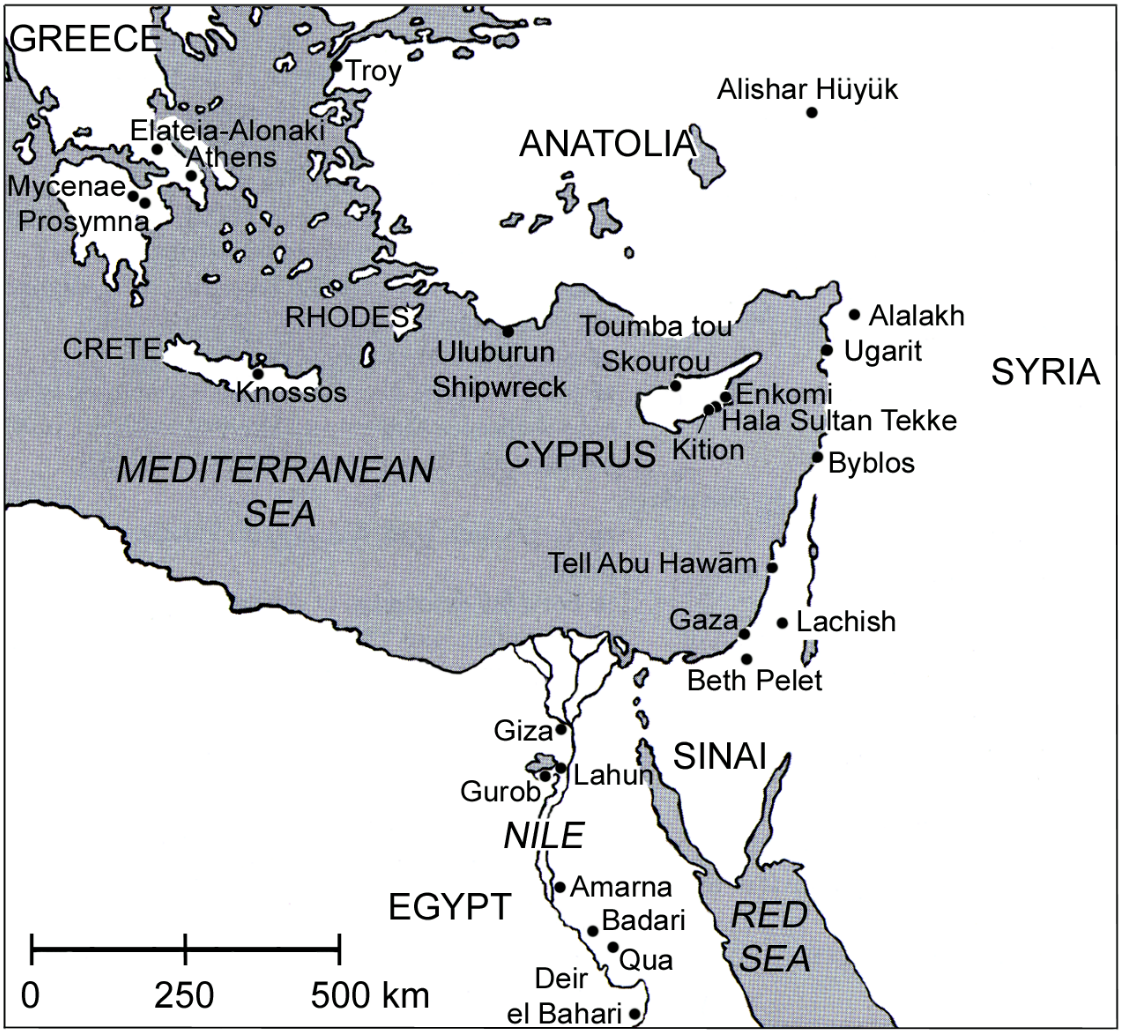

Fig. 1. Location of the Uluburun shipwreck in relation to pertinent Late Bronze Age archaeological sites. (After Friedman 1998, 264, map 1)

The cargo of this ship consisted of both raw materials and luxury items, which correspond to goods mentioned in the late 14th-century Amarna Letters.[7] The metal ingots from the wreck comprise the "single largest assemblage of Bronze Age copper and tin ingots."[8] The cargo also contained ingots of glass, which, upon remelting, could

[7] Pulak 1998, 215.
[8] Pulak 2001, 18.

be formed into a variety of consumer products.[9] Luxury items found include gold jewelry, elephant and hippopotamus ivory, ostrich eggshells and African blackwood, a wood that the ancient Egyptians called *hbny,* from which the modern term "ebony" is derived.[10]

Tens of thousands of beads found on the wreck represent a wide range of beadmaking materials, including glass, faience, Baltic amber, quartz, ostrich eggshell, bone, agate, and carnelian.[11] Multiple types of beads are represented within some materials. Many bead types were items of cargo, as evidenced by a concreted mass of small glass beads transported inside a Canaanite jar. Other, less prolific, bead types represent the personal belongings of the crew or passengers aboard the ship.

Determining the port of origin for this ship is difficult due to the variety of cargo carried. Although the 149 two-handled transport jars on the wreck are Canaanite in origin, the ship also carried a substantial shipment of Cypriot pottery.[12] Nevertheless, the Syro-Palestinian origin for several shipboard items, including lamps, balance weights, stone anchors, and the ship's gold-foil clad bronze deity figurine, confirms a west Asian port of origin, possibly even Ugarit, a city frequently mentioned in the Amarna letters.[13] There is also, however, strong evidence for the presence of two high-ranking Mycenaean officials onboard the ship. These officials probably acted as escorts for a royal shipment of gifts including raw materials and luxury goods from the Syro-

[9] Pulak 1998, 202.
[10] Pulak 1998, 203-6.
[11] Pulak 1998, 206.
[12] Pulak 1998, 201-4.
[13] Pulak 1998, 218; 2001, 14.

Palestinian coast to a final destination in the Aegean.[14] This conclusion accords with the nature of trade during the Late Bronze Age, especially that at Ugarit where, according to J. Sasson, "…the greatest portion of maritime trading enterprises lay in the hands of the king."[15]

Significance and Scope of This Study

The beads found aboard the Uluburun shipwreck are significant because, due to the catastrophic nature of the site, their use may be dated securely to the late 14th century B.C. For beads clearly representing items of cargo, this date applies to both their use and manufacture, while those beads belonging to individuals may have been manufactured at a much earlier date. Beads found in archaeological contexts are notoriously difficult to date due to their extended use throughout generations;[16] the ability to date the beads from Uluburun is, therefore, advantageous.

Since securely dated beads are such a rare find, this Late Bronze Age assemblage must be adequately recorded in order to provide a reliable reference for future archaeological bead studies, which is the intended objective of this thesis. However, both the overwhelming number of beads recovered from this site and the range of bead materials represented preclude such a detailed work from being adequately covered in the scope of one thesis. Therefore, this thesis will focus on beads made of faience and glass only.

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[14] The finds pointing to a Mycenaean presence include swords, knives, spears, seals, amber beads, glass relief-bead pectorals, and pottery sets (Pulak 1998, 218).
[15] Sasson 1966, 134.
[16] Engle 1990, 5.

Faience, a siliceous ceramic, consists primarily of silica with small amounts of soda and lime; its use in beadmaking dates back to the fifth millennium B.C.[17] Faience beads found at Uluburun vary in shape and represent both cargo and personal items. Glass is a soda-lime-silica compound that, unlike faience, is fully melted to a liquid state and sets upon cooling.[18] Two broad categories of glass beads were recovered at Uluburun: wire-wound glass beads and glass relief-beads. The wire-wound glass beads, which include beads of different sizes and decorative elements, will be discussed in this thesis. Glass relief-beads, which were cast in stone molds, are a specific type of bead found in Mycenaean contexts;[19] due to the complexity of this type and the intricate ties between their design and Mycenaean culture, the relief-beads will be excluded from this study.

Bead Use during the Late Bronze Age

Archaeology, iconography, and literary sources confirm the extensive use of beads in the Bronze Age Levant. While the motivation behind such use most certainly includes personal adornment, beads were also instrumental in signifying social status and possessed amuletic or religious value. The use of beads during this period, then, may have been due to one, or a combination, of those three functions: personal adornment, social differentiation, and amuletic use. It is often, however, difficult to attribute a particular find or representation to any one of these three uses. Furthermore,

[17] Moorey 1994, 167-72; Vandiver 1983a, A18.
[18] Moorey 1994, 189.
[19] Hughes-Brock (1999, 287) describes these beads as generally possessing "a flat back and parallel perforations to secure them on two or three strings" while the front bears one of various stylized designs in relief. Some glass relief-beads were cast in bivalve molds and are decorated on both sides.

because beads found in archaeological contexts are seldom in their original pattern of stringing, bead use is often difficult to elucidate, and published reconstructions may be purely speculative. Nevertheless, evidence for each of the three functions has been found in Egypt, western Asia, and the Aegean.

Personal Adornment

Beads were widely worn by both men and women in Egypt, where they were incorporated into collars, necklaces, bracelets, anklets, and girdles. Beads are prolific in Egyptian burials, and "…even the poorest inhumations do not lack a string or two of beads around the neck or arm of the deceased."[20] Perhaps the most easily-recognized form of Egyptian beading is the *usekh*, or multi-strand beaded broad collar. The *usekh* design, developed during the Old Kingdom, remained widely worn by both men and women through the New Kingdom.[21] Other beaded neck ornaments include single strands of beads, as found in both male and female burials,[22] and beaded chokers, which are found only in iconography and appear to have been worn by women of all classes.[23]

Matching bracelets and anklets, composed of multiple strands of beads, were fashionable during the Middle and New Kingdom periods in Egypt and were worn by men and women of high rank.[24] Ceremonial beaded girdles with animal's tails were widely worn by high-ranking men in the Old Kingdom;[25] during the Middle Kingdom, beaded girdles, often incorporating cowrie-shell or acacia-seed beads, were worn by

[20] Aldred 1971, 14.
[21] Wilkinson 1971, 30-1, 108.
[22] Andrews 1991, 123.
[23] Andrews 1991, 117; Wilkinson 1971, 32.
[24] Andrews 1991, 151-3; Wilkinson 1971, 99.
[25] Wilkinson 1971, 78-9.

women, including servants.[26] Egyptian women also wore hair ornaments incorporating beads.[27]

Beads were used in clothing, either strung together in a network[28] or sewn onto cloth in colorful patterns, perhaps in contrast to the linen clothing worn by Egyptians.[29] Among finds in the tomb of the 18th-Dynasty king Tutankhamen are an elaborately beaded robe, a beaded skull-cap, and beaded sandals,[30] which likely served dual purposes of adornment as well as indication of social rank.

At sites on Cyprus and along the Syro-Palestinian coast, beaded jewelry was influenced by both Egyptian and Mycenaean styles due to trade and gift exchange.[31] Throughout western Asia, beads were worn by men and women and were incorporated in necklaces, bracelets, and belts; tiny beads were also sewn onto cloth at Ur.[32] As in Egypt, spacer beads were used to separate the strands of multi-strand bead necklaces.[33] Gold pendants or medallions, such as the Canaanite examples found on the Uluburun shipwreck,[34] were often suspended from necklaces composed of a variety of beads.[35] Colorful beads were also used as pinheads on Cyprus and along the Syro-Palestinian coast.[36]

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26 Andrews 1991, 140-3.
27 Andrews 1991, 109.
28 Brunton 1928, 22.
29 Barber 1991, 154-5.
30 Carter and Mace 1923, 1:123, 167; 2:113.
31 Higgins 1980, 86; Musche 1992, 50.
32 Woolley and Burrows 1934, 369-70.
33 Maxwell-Hyslop 1971, 126, 159-60.
34 Pulak 1998, 206.
35 Maxwell-Hyslop 1971, 125-6; Musche 1992, 145-7, 154.
36 Higgins 1980, 87; Maxwell-Hyslop 1971, 113.

In the Aegean, beads of numerous materials, including both faience and glass, frequently adorn the deceased in Mycenaean burials;[37] although included in burials of both sexes, beads are more common in female burials.[38] Iconography also reveals several uses of beads in the Aegean, although it primarily presents only the upper classes.[39] The most common form of beadwork is the necklace, which may be multi-stranded and include beads of differing color and form; necklaces were worn by men as well as women.[40] Both men and women also wore beaded bracelets and armlets.[41] Earrings, although usually of metal, sometimes incorporated beads to add color.[42] Frescoes from Thera depict women wearing strands of beads in their hair,[43] and there is archaeological evidence for beads used as pinheads in the Aegean.[44]

In addition to inclusion in necklaces and bracelets, some beads may have been sewn onto cloth, as were thousands of tiny, colorful faience beads at Dendra.[45] There is also some archaeological evidence suggesting that Mycenaean relief beads were sewn onto clothing.[46]

Social Differentiation

Beads, so prolific in Egypt, often comprised jewelry which served to designate the social status of the wearer. Although originally associated with priestesses of the goddess Hathor, the *menyet* collar eventually evolved into a symbol of any high-ranking

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37 Lewartowski 2000, 38.
38 Konstantinidi 2001, 21.
39 Effinger 1996, 62-4.
40 Effinger 1996, 60; Hughes-Brock 1999, 278; Konstantinidi 2001, 23.
41 Effinger 1996, 61-2.
42 Higgins 1980, 63.
43 Effinger 1996, 59.
44 Effinger 1996, 82; Hughes-Brock 1999, 282; Konstantinidi 2001, 28.
45 Persson 1931, 106.
46 Effinger 1996, 81-2.

woman; this collar is composed of multiple strands of beads with a large, pendulum-shaped counterpoise.[47] The presence of glass and beadmaking factories at the royal city of Amarna demonstrates a link between the palace and the production of beaded jewelry.[48] Furthermore, some Egyptian tomb paintings show beaded necklaces among the gifts presented to the king by foreigners, confirming that beads were an element of Late Bronze Age palatial gift exchange.[49]

Because costly and elaborate beaded jewelry "…could not be displayed on any scale of magnificence except as the rewards of the king…",[50] such jewelry would indicate favor with the king and thereby impart to the wearer a certain status. *Usekh* collars were at times a royal reward, given by the pharaoh to courtiers or servants; Egyptian nobility mirrored this action, giving *usekh* collars to their servants as well as to the pharaoh.[51] A specific type of royal reward during the 18th-22nd Dynasties was the *shebyu* collar, given to both men and women for military or civil service.[52] The *shebyu* collar is composed of multiple rows of gold disk beads,[53] although similar collars, possibly imitations, were made of faience.[54]

Beaded jewelry also indicated social status in western Asia, and governors or princes of Susa characteristically wore necklaces composed of large beads.[55] Beads were also worn by elite women, as evidenced by the inclusion of strands of beads in the

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[47] Andrews 1991, 185.
[48] Petrie 1974, 25-7.
[49] Davies 1933, 3-8, pls. IV-V; Davies 1935, pls. I, IV, V, XXII.
[50] Aldred 1971, 18.
[51] Wilkinson 1971, 7-9, 32-3.
[52] Wilkinson 1971, 9.
[53] Andrews 1991, 181.
[54] Wilkinson 1971, 108.
[55] Maxwell-Hyslop 1971, 95.

dowry lists of Mitanni princesses.[56] Middle-Assyrian graves of high-status individuals include numerous beads of semi-precious stones as well as glass and faience.[57] At Ur, although both poor and rich graves contained beads, those beads in the rich graves are easily distinguishable by their larger size, deep color, and high stone quality; gold beads were also a signifier of wealth and were always combined with colorful stone beads.[58] Beads are more prevalent in female graves at Ur, but nevertheless are present in high-status male burials at the site.[59]

As at Amarna, the remains of a jewelry workshop in association with the Mycenaean palace at Thebes confirms a link between the palace and the production of beaded jewelry in the Aegean.[60] Mycenaean relief-beads probably designated high social rank or office.[61] In addition to adorning the dead, strands of beads were deposited alongside the deceased, such as the strands of glass and faience beads comprising part of the grave goods in Pit-Cave 66 at Knossos.[62] Bead deposits in graves may imply high social rank, as at high-status graves at Mycenae or Dendra; however, they are also present in the graves of commoners such as those at Prosymna, suggesting that the many bead finds may merely serve to differentiate an individual of any social rank. This is exemplified by a rare find of radially grooved biconical faience beads at Gurob in Egypt; this bead form is scarce in Egypt, and that the beads were found in association with

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[56] Musche 1992, 163-7.
[57] Maxwell-Hyslop 1971, 173-4.
[58] Woolley and Burrows 1934, 370.
[59] Woolley and Burrows 1934, 366.
[60] Symeonoglou 1973, 72.
[61] Hughes-Brock 1999, 291.
[62] Evans 1906, 71-2.

Aegean and Cypriot pottery suggests that they were owned by a foreigner, who perhaps expressed his cultural identity through the use of distinctive beads.[63]

Amuletic or Religious Properties

Beads in ancient Egypt possessed a distinct amuletic value, and there is an etymological link between the Egyptian term for luck and that for bead.[64] Amulets in the form of beads and pendants were widely used in Egypt, as evidenced by the thousands of clay molds used in the production of faience amulets at Amarna.[65] Many varieties of eye beads and pendants were also found in Bronze Age Egypt, which perhaps protected the wearer against the evil eye.[66] This belief in the powers of the evil eye, also commonly known as "fascination", was a widespread phenomenon in the ancient world. The primary cause of fascination is envy,[67] and, in many parts of the Mediterranean today, the simplest charm to protect against this harmful force is a bead representing an eye or merely a blue bead, worn attached to clothing or jewelry.[68]

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[63] Petrie 1891, 17, no. 26.
[64] Dubin 2004, 42.
[65] Petrie 1974, 28-30.
[66] Brunton 1928, 25.
[67] Gifford 1958, 20.
[68] Maloney 1976, 49. The color blue itself symbolizes protection against the evil eye, and the majority of eye beads that continue to be produced in the eastern Mediterranean are blue. There exist differing explanations for this preoccupation with the color blue. Adorning donkeys with blue or turquoise beads might be linked to a belief that the stone turquoise enhances the sure-footedness of the animal (Erikson 1993, 135). Several anthropologists link the commonality of blue eye beads with the rarity of that genetic trait in eastern Mediterranean regions (Maloney 1976, 8, 80; Gifford 1958, 21-2). Gifford furthermore suggests that any eye abnormality, whether an uncommon color or a rare defect such as double pupils, suggests an inclination toward fascination. Because studies in magic suggest that "like produces like", incorporating an abnormality into a talisman will enhance its ability to draw the gaze of a fascinator; the frequent depiction of double pupils on eye beads of various periods certainly supports this theory. Perhaps, though, the proliferation of blue beads simply occurred because of the ease with which that color is obtained in both glass and faience. Kűçűkerman (1988, 81), in studying the glass bead industry in Turkey, suggests that, because various factors such as temperature, oxidation level and rate of cooling have relatively little effect on this blue color, it might have been the test color in the developmental stages of glassmaking. It would follow, then, that blue beads were the most widely available, and the preference

Faience beads were highly valued in Egypt, seemingly due to the material's symbolism of rebirth and its association with the god Osiris rather than its inherent value.[69] Beaded necklaces or collars also adorned statues of the Egyptian gods.[70] Strands of beads served as votive offerings in Bronze Age Egypt, and such strands were dedicated to the goddess Hathor by the thousands at the 11th-Dynasty temple at Deir el-Bahari.[71] An association between the temple and the manufacture of beaded jewelry is suggested by tomb depictions of temple workshops; one such depiction may be found in the tomb of Amenhotpĕ, a priest of Amūn under Tuthmosis IV. In one scene, Amenhotpĕ inspects the drilling of stone beads as well as the stringing of beads into an *usekh* collar; in another scene, the finished products from the workshop are displayed before the king for approval and eventually serve as gifts from the king to Amūn.[72]

The amuletic properties of beads were recognized in western Asia, and beads of various stones were believed to impart a range of healing or protective properties.[73] A range of glass and faience eye beads of first millennium B.C. date were found at Alishar Hüyük in Anatolia, again serving as amulets against fascination.[74]

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for them led to a general preoccupation with the color, such that today a piece of blue ribbon is a sufficient deterrent to the evil eye. A fourth explanation for the protective associations with the color blue, as suggested by V. Garrison and C. Arensberg, is that it represents royalty and, therefore, implies the protection of a higher power. This is perhaps due to an association between royalty and the blue stone lapis lazuli, a precious stone prized and possessed by royalty during the Bronze Age. Wearing or carrying something blue, then, served as "…a warning to any potential encroacher that his seizure would be followed by retaliation." (Maloney 1976, 311)

[69] Friedman 1998, 24-5.
[70] Aldred 1971, 14.
[71] Naville 1913, 28.
[72] Davies 1923, 10-2, pl. X. Depictions of bead drilling and stringing in temple workshops may also be seen in the tomb of Nebamun and Apuki (Davies 1925, 57, 63, pl. XI).
[73] Musche 1992, 58.
[74] Schmidt 1933, 2:84-5.

A religious association with beads is confirmed by their presence in Late Bronze Age temples in western Asia. The 15th-century B.C. temple A at Nuzi was decorated with over 16,000 beads, some of them eye beads, which were set into bricks, sewn onto decorative textiles, and strung along the walls, supported by glazed wall-nails.[75] Numerous beads, possibly part of a votive offering or the equipment of a priest, were also found at the Late Bronze Age temple at Lachish near the Syro-Palestinian coast.[76]

As early as the 4th millennium B.C., a beaded necklace was an identifying mark of the Sumerian goddess Inanna (Akkadian Ishtar) and recurs on goddess figurines from western Asia to the Balkans.[77] Such a necklace is instrumental in Ishtar's oath after the flood in *The Epic of Gilgamesh*: "Then, at last, Ishtar also came, she lifted her necklace with the jewels of heaven that once Anu had made to please her. 'O you gods here present, by the lapis lazuli round my neck I shall remember these days as I remember the jewels of my throat; these last days I shall not forget.'"[78]

Although the use of amulets in Mycenaean contexts is not fully understood, it is clear that amulets of the Egyptian style were not prevalent in the Aegean.[79] Carnelian beads appear to have held a distinct amuletic value in the Late Bronze Age Aegean and are almost always found in the graves of children;[80] there is also a link between beads in general and children's burials.[81] The presence of a belief in fascination is suggested by

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[75] Starr 1939, 92-4.
[76] Tufnell et al. 1940, 74-5.
[77] Crawford 1956, 26-7, 59; Maxwell-Hyslop 1971, 151-7.
[78] Sandars 1964, 109.
[79] Hughes-Brock 1999, 280, 285.
[80] Konstantinidi 2001, 244.
[81] Lewartowski 2000, 35.

eye beads found in Mycenaean burials.[82] As in Egypt and western Asia, strands of beads, often of simple form, served as votive offerings.[83]

In summary, then, it is clear that beads were used for multiple, sometimes overlapping, purposes throughout the Bronze Age Levant. Although men wore beaded jewelry, their use thereof appears to be primarily as a designation of high social rank rather than aesthetic adornment. Women wore beads more frequently and in a wider range of styles; their use thereof appears to be primarily aesthetic, although beads are often associated with goddesses and religious rites involving females as well.

[82] Wace 1932, 94.
[83] Nikita 2003, 34.

CHAPTER II

CATALOGUE

Methodology

An adequate catalogue must include a range of data, including detailed measurements, descriptions, drawings, and photographs. In studying the beads from Uluburun, a set of metric dial calipers provided bead dimensions accurate to one-tenth of a millimeter. A dissecting microscope also proved indispensable, as it allowed observation of minute details not visible to the naked eye. Finally, a digital camera in macro mode was used to photograph samples of each category, placed on a light table to minimize shadow.

In order to be of value to future research, a catalogue must utilize terms that are both scientifically defined and generally accepted. Unfortunately, bead studies often suffer from a lack of consensus on terminology. Horace C. Beck recognized this issue and, in an effort to resolve it, published *Classification and Nomenclature of Beads and Pendants* in 1928.[1] Because Beck's typology remains the most comprehensive and concrete method available, it is utilized herein; other typology systems, where applicable, are also noted.

In addition to establishing a system of classification through the assignment of a combination of letters and numerals, Beck's work defines a standardized vocabulary for use in bead studies. Appendix A, containing a glossary of terms used in this catalogue,

[1] Beck 1981.

is based on Beck's terminology as well as that outlined in *The Bead Dictionary* by Peter Francis, Jr.[2]

The beads are organized by material (faience or glass) and divided into categories. Each category is exemplified by one or more individual beads, which is catalogued in detail with dimensions, illustrations, and a description of notable characteristics. Due to the diminutive size of many beads, illustrations are drawn at a scale of 3:1; furthermore, each illustration includes two (or more) views of the artifact so that the category may be easily identified. A general description and average dimensions of all beads of that category follow. Average dimensions are based on measurements of the remaining beads in that category or, for those containing more than 100 beads, a sample set thereof; tables of individual dimensions as well as photographs of the beads are available in appendix B.

In addition to the above, the complete analysis of each bead category also includes a discussion of parallel finds from contemporary archaeological sites. Due to the widespread trade in both faience and glass beads during the Late Bronze Age, and because some beads from Uluburun represent cargo and some personal, possibly Mycenaean, belongings,[3] sites throughout the Levant are discussed. A significant amount of archaeological research has been undertaken at Bronze Age sites since the 19th century, and many excavations have recovered beads among other artifacts. Beads and other forms of ornamentation were often deposited alongside datable artifacts such as pottery or weapons in Bronze Age graves; as a result, publications of burial sites often

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[2] Francis 1989.
[3] Pulak 1988, 37.

prove the best resource for bead studies. Late Bronze Age graves containing beads similar in style to those from Uluburun occur throughout ancient Greece, Cyprus, southern Anatolia, the Syro-Palestinian coast, and Egypt. Datable bead deposits that do not constitute grave goods, while considerably less frequent, are also discussed.

Faience Beads

The faience beads recovered from the Uluburun shipwreck form eight general categories, as outlined in Table 2.1.[4] Some categories include one or more subcategories representing beads exhibiting slight differences in decoration, proportion, or technique of manufacture.

There are a few exceptional faience beads with patches of preserved glaze, always bright blue in color. The overwhelming majority of faience beads, however, no longer retains any original glazing. Due to the attrition caused by the marine environment, the original glazed surface is often completely eroded, leaving the bead with a pitted, granular, friable surface and giving the illusion of a gray or white color. Such erosion also increases the bead's porosity and consequently its susceptibility to staining resulting from other agents in close proximity.

[4] The common name for each category was selected to represent that category's most recognizable feature, usually referring to its decoration, form, or size.

Table 2.1. Categories of faience beads found on the Uluburun shipwreck.

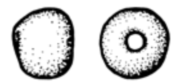
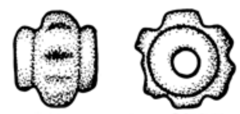
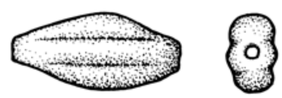
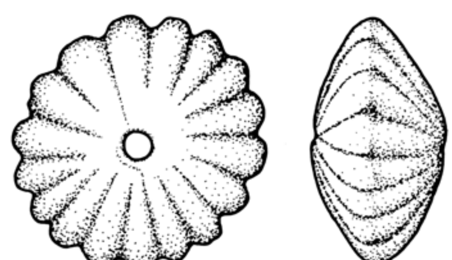
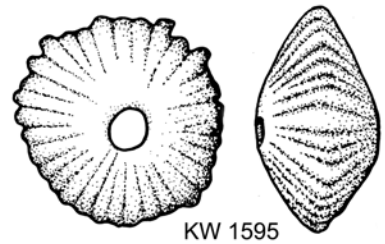
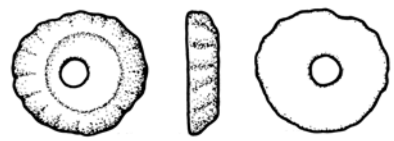
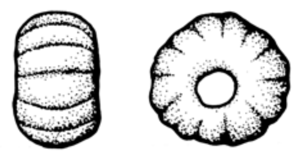
Category Name	Quantity	Beck No.	Sample Illustration
1. Tiny	Approx. 72,000	I.A-B.1-2.b	 Lot 9463
Segmented	Unknown	XVII.A.I.a	 Lot 9463
2. Globular	Approx. 1,600	I.B-C.1.a-b	 KW 3980
3. Cogwheel	Approx. 800	XXIII.A.2.a	 KW 2496
Collared Cogwheel	17	XXIII.A.2.a, collared	 KW 4568
4. Grain-of-Wheat Variant A	153	XXVI.A.3	 KW 3947
Variant B	43	XXVI.A.3	 KW 5612
Variant C	2	XXVI.A.3	 KW 5635
5. Biconical Variant A	52	XXIII.A.3.d	 KW 1377

Table 2.1 Continued

Category Name	Quantity	Beck No.	Sample Illustration
5. Biconical Variant B	2	XXIII.A.1.d	 KW 1595
6. Grooved Barrel	14	XXIII.A.1.a	 KW 5472
7. Button	5	XXIII.A.2.e	 KW 3481
8. Gadrooned Spheroid	1	XXIII.A.3.a (oblate)	 KW 5174
			 0 1 2 cm

<u>Tiny Beads</u>

Inv. No. Lot 9463.a N16 LL4
Beck No. I.B.2.b Perforation IV, VIa
Diam. 0.46 cm; length 0.16 cm; diam. of perforation 0.2 cm.
Length to diameter ratio: 0.35 (short)
Short, cylindrical (discoid) faience bead (fig. 2.1). Mottled, powdery surface of white and yellow-green with spots of bright blue-green discoloration. Plain, medium-large perforation.

Inv. No. Lot 9463.b N16 LL4
Beck No. I.B.2.b Perforation IV, VIa
Diam. 0.23 cm; length 0.08 cm; diam. of perforation 0.11 cm.
Length to diameter ratio: 0.35 (short)
Short, cylindrical (discoid) faience bead (fig. 2.1). Muted red in color with a mottled granular surface. Plain, medium-large perforation.

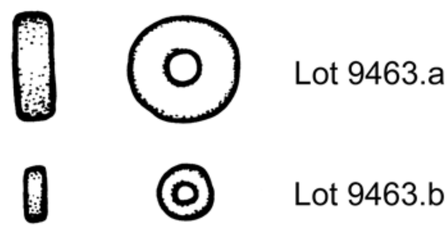


Fig. 2.1. Tiny faience beads from Lot 9463. Scale 3:1.

Roughly 72,000 tiny faience beads were recovered from the Uluburun shipwreck. These beads range in diameter from just under two to five millimeters; a sample of 100 tiny faience beads yielded the following dimensions:[5]

Average diameter:	0.27 cm
Average length:	0.12 cm
Average perforation diameter:	0.12 cm

Tiny beads possess flat ends and a profile that is either straight or slightly convex, and their length-to-diameter ratio approaches that of disk beads. They are characterized by significant variation in both size and coloration. Colors include red, blue, white, yellow, and turquoise; green and black may also be present, although these colors may result from staining. The original surface glaze no longer remains, and some beads may have had glaze of a different color; for example, small, glassy patches of yellow or orange are visible on some of the red beads when viewed under low

[5] For measurements and photographs of each sample bead, see app. B, 140-7.

magnification. Tiny beads are often found adhering to one or two other tiny beads, although always of the same relative size and color.

Fig. 2.2. Concreted mass of tiny faience beads KW 76.

An estimated 68,000 tiny faience beads were found as a concreted mass (KW 76, fig. 2.2). Although the original color of the beads in this concretion is no longer discernible, the beads exhibit less variation in size than do other beads in this category. They are 0.21-0.31 cm in diameter (average 0.27 cm) and 0.10-0.17 cm in length (average 0.13 cm).[6]

Similar beads from other sites have been labeled as disk, flat-ring or annular beads.[7] They have been found at Bronze Age sites throughout the Levant in faience as well as gold, ostrich eggshell and various stones. Tiny beads are abundant in Egypt. The 18th-Dynasty king Tutankhamen was entombed wearing a skull-cap intricately embroidered with such beads, which were also used in bracelets, necklaces and earrings

[6] The sample dimensions of beads as well as calculations to determine the number of beads present in concreted mass KW 76 are provided in app. C.
[7] Petrie et al. 1923, pl. LXII; Karantzali 2001, 73; Blegen et al. 1973, 91.

found in the tomb.[8] Jewelry recovered from the grave of the 12th-Dynasty princess Sit Hat-Hor Yunet at Lahun includes bracelets composed of hundreds of tiny beads of gold, turquoise and carnelian.[9] Tiny faience beads have also been found in numerous New Kingdom tombs in Egypt.[10]

Tiny beads are common at sites along the Syro-Palestinian coast, and examples in faience have been found in 14-13th-century contexts at Alalakh,[11] Tell Abu Hawām,[12] and Lachish, among others.[13] The style enjoyed a lengthy popularity in Mesopotamia; in Larsa, an 18th-century B.C. jar containing the tools and materials of a goldsmith also held nearly 3,000 tiny faience beads, and another 4,500 were recovered at a contemporary site nearby.[14] Tiny beads were still in use in the region during the 14th century B.C. at Tell Zubeidi.[15]

Tiny faience beads of Late Bronze Age date were found at Cypriot sites including Hala Sultan Tekke[16] and Toumba tou Skourou.[17] Slightly larger faience beads of this type found at Kissonerga date to the 3rd millennium B.C. and are likely imports

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8 Carter and Mace 1923, 2:113.
9 Brunton 1920, 33.
10 Sites include Gurob (Brunton and Engelbach 1927, pls. XIV-XVIII, XLV), Harageh (Engelbach 1923, pl. LIV, nos. 85 and 92), Lahun (Petrie et al. 1923, pl. LXII, nos. 85 and 92), Qua and Badari (Brunton 1930, pl. XXXII, nos. 76 and 78).
11 Woolley 1955, 270, no. 15.
12 Hamilton 1935, 62, no. 399 a.
13 Tufnell et al. 1940, pl. XXXIV, nos. 1-4, pl. XXXVI, nos. 103-106.
14 Arnaud et al. 1979, 39, nos. L.76.110-L.76.111.
15 Boehmer and Dämmer 1985, 55, no. 536A.
16 Åström et al. 1983, 123, no. N 2024.
17 Vermeule and Wolsky 1990, 345, no. T II.34 J7.

from Egypt or western Asia.[18] Tiny beads of ostrich eggshell and black and green faience have also been found at Tarxien on Malta.[19]

This bead category is well-represented in the Aegean, and 1,600 tiny blue faience beads were found in the MMI Vat Room Deposit at Knossos.[20] Tiny beads are commonly found in Mycenaean graves,[21] and more than 40,000 examples in white, yellow, blue, brown and black faience were recovered from chamber tomb 2 at Dendra.[22] Furthermore, the variation in size and color seen at Uluburun is repeated in contemporary finds of tiny beads from Pylos in Messenia[23] and Pylona on Rhodes.[24]

In addition to regular rounded (division I) beads, the tiny beads at Uluburun include a special group known as segmented beads (Beck No. XVII.A.1).[25]

Inv. No. Lot 9463.c N16 LL4
Beck No. XVII.A.1.a Perforation IV, VIb
Diam. 0.2 cm; length 0.2 cm; diam. of perforation 0.1 cm.
Small, segmented faience bead with two segments (fig. 2.3). Each segment exhibits a convex profile. Light blue in color with a mottled granular surface. Plain, extra-large perforation.

Inv. No. Lot 9463.d N16 LL4
Beck No. XVII.A.1.a Perforation IV, VIb
Diam. 0.17 cm; length 0.31 cm; diam. of perforation 0.1 cm.
Small, segmented faience bead with three segments (fig. 2.3). Each segment exhibits a convex profile. Blue in color but heavily obscured by yellow staining. Plain, extra-large perforation.

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18 Peltenburg 1995.
19 Murray et al. 1934, 4.
20 Panagiotaki 1998, 178.
21 Blegen and Blegen 1937, 1:311-2, no. 12; Haevernick 1981, 404, no. 8; Wace 1932, 48, no. 6; Xenaki-Sakellariou 1985, 295, no. 31.
22 Persson 1931, 106, no. 51.
23 Blegen et al. 1973, 91, no. NM. 7877.
24 More than 300 such beads were found in the LH III tombs 1 and 2 at Pylona (Karantzali 2001, 73-5, nos. 676 and 698).
25 Beck 1981, 13-4.

Fig. 2.3. Segmented faience beads from Lot 9463. Scale 3:1.

The segmented beads at Uluburun have a diameter of around 0.2 centimeters and possess two, three, four, or, in one instance, five segments; they are almost always red or blue, on occasion off-white. Although infrequent, some segmented beads exhibit a taper at one end, at which the perforation or bead profile is usually distorted. Other segmented beads were found adhering to regular tiny beads of the same color.

The dimensions and color of the segmented and regular tiny beads are so similar as to suggest manufacture in close association. Although segmented faience beads comprise a distinct style during the Late Bronze Age, it is possible that those found at Uluburun were not produced intentionally, but instead result from incomplete formation of regular tiny faience beads.[26] Similar beads at Prosymna are grouped together as segmented beads, although some possess only one segment and may therefore be interpreted as a regular rounded (division I) tiny bead.[27] Segmented beads were also intermixed with the large find of 40,000 tiny beads at Dendra.[28]

Segmented beads, like their non-segmented counterparts, have been found at archaeological sites throughout the Levant. While most often described as segmented,

[26] The manufacture of these beads will be discussed in ch. IV.
[27] Blegen and Blegen 1937, 1:310.
[28] Persson 1931, 106, no. 51.

this group has also been referred to as multiple-ring beads or simply multiple beads.[29] Beads at other sites usually possess between two and seven segments. While Woolley notes that they comprise an early type not seen after the 15th century B.C. at Alalakh,[30] segmented beads are present in 14th-century and later contexts at numerous sites in Egypt, western Asia, and the Aegean.[31] Segmented beads have also been found in surprisingly large numbers in Bronze Age burials in Britain, where the "normal", rather than "Scottish", segmented beads resemble those from the Uluburun shipwreck.[32] These beads are of foreign origin and were likely imported in the 14th century B.C.[33]

<u>Globular Beads</u>

Inv. No. KW 3980 N18 LR2
Beck No. I.B.1.a (spheroid) Perforation IV, VIa
Diam. 0.54 cm; length 0.47 cm; diam. of perforation 0.19 cm.
Length to diameter ratio: 0.87 (short)
Oblate spheroid (fig. 2.4). Pale blue with a less mottled appearance than most beads of this type. Original surface glaze completely eroded. Small pitting visible near plain, medium-large perforation.

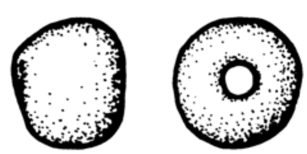

Fig. 2.4. Globular faience bead KW 3980. Scale 3:1.

[29] Woolley 1955, 270, no. 22; Brunton and Engelbach 1927, pl. XLIII; Petrie et al. 1923, pl. LXII.
[30] Woolley 1955, 269.
[31] Sites include Gurob (Brunton and Engelbach 1927, pls. XIV-XVIII, XLIII) and Lahun (Petrie et al. 1923, pl. LXII) in Egypt; Lachish (Tufnell et al. 1940, pl. XXXV, nos. 70-78; Tufnell 1958, 88, pl. 29, nos. 27-28) and Megiddo (Loud 1948, pl. 213, no. 66) along the Syro-Palestinian coast; and Pylona (Karantzali 2001, 73-4, no. 675) and Mycenae (Xenaki-Sakellariou 1985, 295, no. 25) in the Aegean.
[32] Beck and Stone 1936, 205-6.
[33] Beck and Stone 1936, 233.

The shipwreck yielded around 1,600 globular faience beads. This type of bead, roughly spherical with a convex profile, is designated by Beck as a spheroid.[34] Analysis of a sample of 100 globular faience beads produced the following dimensions:[35]

Average diameter:	0.54 cm
Average length:	0.42 cm
Average perforation diameter:	0.18 cm

Globular bead size and form vary slightly due to nuances of the process of manufacture. The majority of beads analyzed are oblate spheroids (I.B.1.a); a number of different forms, however, are contained within the spheroid group, so that the I.B.1.b beads with slightly flattened ends are included here as well.

Globular beads frequently exhibit staining, causing beads to appear in a range of colors including shades of gray, brown, and blue. Magnification reveals the actual color of each globular bead to be blue, varying only in value and chroma. In rare beads, a deep, intense blue preserved around the perforation is readily visible without the aid of magnification. In most cases, discoloration due to staining is easy to detect, as many stains occur in distinct patches contrasting the actual color of the bead. Among the beads studied, stains tend to be red-brown, yellow-brown, or bright green, the latter most certainly resulting from copper contamination. Minor pitting, although infrequent, does occur in this group and is most apparent around the perforation; small pits are often emphasized by a red-brown discoloration. Flaws incurred during the formation process,

[34] Beck 1981, 7 n. 1.
[35] For measurements and photographs of each sample bead, see app. B, 148-55.

resulting in skewed beads, as well as the firing process, resulting in beads or fragments thereof adhering to other beads, are often evident.[36]

Like tiny beads, globular beads are ubiquitous in Bronze Age contexts throughout the Levant. In Greece it is the most common form of faience bead,[37] and examples thereof are usually some shade of blue or gray.[38] Beads nearly identical to the Uluburun globular beads in both form and dimension occur at Aidonia,[39] Dendra,[40] Prosymna,[41] and Pylos.[42] They are common at Mycenae and correspond to Xenaki-Sakellariou's type 1 (spherical) or type 2 (rounded).[43] Similar beads dating to LC III are found on Cyprus.[44]

Globular beads are also common along the Syro-Palestinian coast, with close parallels to the Uluburun beads found at Tell Abu Hawām[45] and Megiddo.[46] Such beads are also present in 12th-century B.C. graves at Tell Zubeidi in Mesopotamia.[47] Similar beads were found in 18th-Dynasty contexts in Egypt.[48]

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[36] These flaws will be discussed in light of bead manufacture in ch. IV.
[37] Lewartowski 1987, 129.
[38] Blegen and Blegen 1937, 1:307-8; Blegen et al. 1973, 170; Wace 1932, 86, no. 71f.
[39] Demakopoulou 1996, 66, no. 56.
[40] Persson et al. 1942, 50, no. 20.
[41] Blegen and Blegen 1937, 1:307-8.
[42] Blegen et al. 1973, 170.
[43] Wace 1923, 382, no. 4541a; Wace 1932, 86, no. 71f; Xenaki-Sakellariou 1985, 292, nos. 1-2.
[44] Åström (1967, 48-9) provides an overview of globular faience beads on Cyprus. These beads were also found at Enkomi (Courtois 1984, 148, no. 1242) and Hala Sultan Tekke, where the perforation of one of the globular faience beads is lined with gold, to which gold caps are attached at each end (Åström et al. 1983, 177-8, nos. N 1237, N 1374, and N 1385).
[45] Hamilton 1935, 62, no. 396.
[46] Loud 1948, pl. 212, no. 55.
[47] Boehmer and Dämmer 1985, 55, no. 537.
[48] Globular beads have been found at Amarna (Frankfort and Pendlebury 1933, pl. L, no. XXXI), Gurob (Brunton and Engelbach 1927, pl. XLV, nos. 79-80), Harageh (Engelbach 1923, pl. LIV, no. 80b), and Lahun (Petrie et al. 1923, pl. LXII, no. 80 P).

<u>Cogwheel Beads</u>

Inv. No. KW 2496 L16 UR1
Beck No. XXIII.A.2.a Perforation IV, VIa
Diam. 0.66 cm; length 0.51 cm; diam. of perforation 0.23 cm.
Length-to-diameter ratio: 0.77 (short)
Oblate fluted spheroid of faience, resembling a cogwheel in transverse section (fig. 2.5). Light blue color is partially obscured by powdery surface and some pale yellow-brown discoloration. Bead shape is well-preserved with five concave bands or flutes producing five ribs of varying widths. Plain, medium-large perforation.

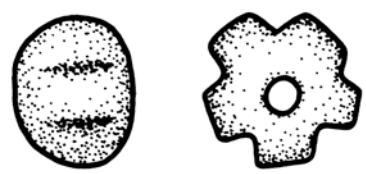

Fig. 2.5. Cogwheel faience bead KW 2496. Scale 3:1.

Nearly 800 cogwheel beads were recovered from the shipwreck. These beads are typically spheroid with between four and seven flutes and thus fall under Beck no. XXIII.A.2.a. Analysis of a sample of 100 cogwheel faience beads produced the following dimensions:[49]

Average diameter:	0.68 cm
Average length:	0.52 cm
Average perforation diameter:	0.21 cm
Average number of flutes:	5-6

Although physical wear on the bead surface is common among the cogwheel beads, general bead form is well-preserved. The number of flutes present varies independently of the bead's diameter or profile. Widths and depths of flutes even vary

[49] For measurements and photographs of each sample bead, see app. B, 156-63.

within the same bead, as exhibited by bead KW 4782. A number of irregular beads are present in this group, including double, elongated, and seemingly unfinished beads.[50]

All cogwheel beads analyzed appear blue under low magnification, often obscured by stains of dark red-brown in addition to the yellowish and lighter brown seen on other faience beads. This frequent staining, combined with the effects of erosion on the bead surface, cause the assemblage to present a range of colors, including various shades of blue, brown, gray, and white. Unlike the other types of faience beads, though, some rare cogwheel beads retain patches of bright blue glaze on their outer surface, such as that seen on KW 3317 (fig. 2.6), and offer a glimpse of how these beads might have appeared at the time of their use.

Fig. 2.6. Cogwheel faience bead KW 3317 with partially preserved surface glaze. Scale 3:1.

The cogwheel group contains a special sub-group known as collared cogwheel beads, so-called due to the presence of a collar or distinct convex band around the perforation at each end. These collared cogwheel beads occur infrequently at Uluburun—only 17 have been identified—and are sometimes difficult to distinguish from plain cogwheel beads.[51]

[50] These flaws will be discussed in light of bead manufacture in ch. IV.
[51] For measurements and photographs of sample beads, see app. B, 164-5.

Inv. No. KW 4568 N18
Beck No. XXIII.A.2.a, collared. Perforation IV, VIa
Diam. 0.79 cm; length 0.69 cm; diam. of perforation 0.21 cm; collar diam. 0.52 cm; collar length 0.15 cm.
Length-to-diameter ratio: 0.87 (short)
Oblate fluted spheroid of faience, resembling a cogwheel in transverse section, with a distinct collar at each end (fig. 2.7). Surface is granular and gray-blue in color. Erosion along bead perimeter primarily affects ribs; approximately six ribs present, two of which are either misshapen or heavily worn. Plain, medium-large perforation.

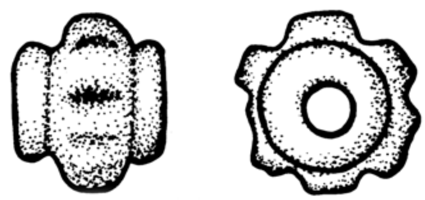

Fig. 2.7. Collared cogwheel faience bead KW 4568. Scale 3:1.

Parallels for both plain and collared cogwheel beads exist in Egypt, western Asia, and the Aegean, although many of the plain variety are disk beads rather than the short or standard-length cogwheel beads found at Uluburun. Plain cogwheel beads were found in 18th-Dynasty contexts in Egypt,[52] and similar beads in blue, green and black faience are common in the Egyptian pan-graves.[53] Collared cogwheel beads are less common in Egypt, but examples have been found dating to the 2nd Intermediate Period temple at Badari.[54]

[52] Such beads are present at Amarna (Frankfort and Pendlebury 1933, pl. L, no. LVII) and Gurob (Brunton and Engelbach 1927, pl. XLIII, no. 47 D).
[53] Although labeled by Wainwright (1920, 59, pl. XXII, no. 1) as melon beads, some of the Balabish beads closely resemble the cogwheel form seen at Uluburun. This type is also seen in pan-graves near Hemamieh in Eypgt (Brunton 1930, pl. XI, no. 19).
[54] Brunton 1930, pl. XI, no. 84.

Irregularity in rib size and spacing as seen at Uluburun occurs on plain cogwheel beads from Megiddo on the Syro-Palestinian coast[55] and Toumba tou Skourou on Cyprus.[56] Collared cogwheel beads are also present at Megiddo, but are roughly made in contrast to those found at Uluburun.[57] Collared cogwheel beads occur frequently in gold in Mesopotamia and constitute much of the well-known Dilbat necklace.[58] Closer collared parallels exist at Beth Pelet,[59] Amman,[60] and Lachish,[61] at which plain cogwheel beads were found as well.[62]

Plain cogwheel beads similar to those at Uluburun are abundant on the Greek mainland; they correspond to type four at Mycenae[63] and were found in several chamber tombs, sometimes in large numbers, both there and at Dendra.[64] As at Uluburun, a LH III cogwheel bead at Elateia-Alonaki was the only faience bead at the site to retain a bright blue surface glaze.[65] Collared cogwheel faience beads have also been found in large numbers at the chamber tombs at Mycenae[66] and the tholos tomb at Menidi.[67] A group of 25 was found in tomb 1 at Pylona on Rhodes,[68] and such beads correspond to Effinger's spherical bead variant C on Crete.[69]

[55] Loud 1948, pl. 208, no. 21.
[56] Vermeule and Wolsky 1990, 345, pl. 131.
[57] Loud 1948, pl. 212, no. 55.
[58] Maxwell-Hyslop 1971, 88-9.
[59] Starkey and Harding 1932, pl. LXXII, no. K28.
[60] Hankey (1995, 176-7, no. 5885j) admits some confusion as to whether this type is glass or faience.
[61] Tufnell et al. 1940, pl. XXXV, no. 51; Tufnell 1958, pl. 29, nos. 33 and 35.
[62] Tufnell et al. 1940, pl. XXXV, no. 49; Tufnell 1958, pl. 29, no. 35.
[63] Xenaki-Sakellariou 1985, 292, no. 4, pl. 126, no. 3203(2).
[64] Persson et al. 1942, 86, no. 32e.
[65] Nightingale 1996, 144, no. T LVII/5og/1.
[66] Xenaki-Sakellariou 1985, 293, no. 10.
[67] Deutsches Archäologisches Institut 1880, 21; Demakopoulou 1996, 116-7, no. 59.
[68] Karantzali 2001, 74, no. 677.
[69] Effinger 1996, 25-6, no. 2.5.1.5 Variante C.

<u>Grain-of-Wheat Beads</u>

This bead type depicting a grain of wheat, often found in Mycenaean contexts, occurs in numerous variants, three of which are represented at Uluburun:

Variant A:
Inv. No. KW 3947 O18 LL4
Beck No. XXVI.A.3 (grain-of-wheat) Perforation IV
Diam. 0.72 cm; min. diam. 0.4 cm; length 1.51 cm; diam. of perforation 0.13, 0.15 cm; diam. of end 0.23, 0.27 cm.
Length-to-diameter ratio: 2.1 (long)
Faience bead shaped like a grain of wheat (fig. 2.8). Flattened amygdaloid form with five grooves forming five ribs or gadroons on one side, and four grooves on the opposite side. Central groove extends to bead end on only one face. Medium blue, with color more intense in grooves and around perforation, possibly due to better preservation. Remaining surface powdery gray with some patches of brown discoloration. Distinct greenish-blue glaze and brighter blue color visible inside perforation at one end. Perforation is approximately straight (plain).

Fig. 2.8. Grain-of-wheat variant A faience bead KW 3947. Scale 3:1.

Variant B:
Inv. No. KW 5612 O17 UR4
Beck No. XXVI.A.3 (grain-of-wheat) Perforation IV, VIa
Diam. 0.62 cm; min. diam. 0.43 cm; length 1.39 cm; diam. of perforation 0.18, 0.17 cm; diam. of end 0.3, 0.25 cm.
Length-to-diameter ratio: 2.24 (long)
Faience bead shaped like a grain of wheat (fig. 2.9). Amygdaloid form, slightly flattened, with two grooves on each side forming three large, rounded gadroons. The gadroons closest to the bead edge curve around to join the next gadroon on the opposite face, so that four lobes are present in transverse section, those at the bead edge being the largest. On one face, grooves are of uniform depth and spacing, while on the reverse, grooves are off-center with one groove (that closest to the bead perimeter) significantly shorter and shallower than the other. Granular surface is light blue-gray with white flecks and patches of pale reddish-brown staining on either face. Minor pitting on one face. Medium-large perforation, approximately straight (plain).

Fig. 2.9. Grain-of-wheat variant B faience bead KW 5612. Scale 3:1.

Variant C:
Inv. No. KW 5635 O17 UR4
Beck No. XXVI.A.3 (grain-of-wheat) Perforation IV, VIa
Diam. 0.53 cm; length 1.72 cm; diam. of perforation 0.19 cm; diam. of end 0.37, 0.34 cm.
Length-to-diameter ratio: 3.25 (long)
Faience bead shaped like a grain of wheat (fig. 2.10). Fusiform bead with five longitudinal flutes that do not extend to bead ends; resultant ribs vary in width. This bead resembles a cogwheel bead in transverse section. Medium blue in color, with pitting visible throughout; red-brown discoloration more visible in pits and in flutes. Plain, medium-large perforation.

Fig. 2.10. Grain-of-wheat variant C faience bead KW 5635. Scale 3:1.

198 faience grain-of-wheat beads were found on the shipwreck: 153 beads of variant A, 43 beads of variant B, and 2 beads of variant C. Analysis of a sample of 100 grain-of-wheat faience beads yielded the following dimensions:[70]

Average diameter:	0.66 cm
Average thickness:	0.40 cm
Average length:	1.56 cm
Average perforation diameter:	0.15 cm

Blegen suggests that the true grain-of-wheat form is that represented in variant B (KW 4523) and other forms merely "poor imitations" thereof.[71] Although variant C is both less common and easily identified, variants A and B can, at times, be indistinguishable, confirming Effinger's statement that "Varianten dieses Typus lassen sich aufgrund der nur geringfügigen Unterschiede nicht klar abgrenzen."[72] This being the case, the aforementioned variants should be used as a general guide to understanding the forms and frequency thereof.[73]

[70] For measurements and photographs of each sample bead, see app. B, 166-74.
[71] Blegen and Blegen 1937, 1:311.
[72] Effinger 1996, 25.
[73] Illustrations of beads found at Menidi (Deutsches Archäologisches Institut 1880, pl. III) and Mycenae (Xenaki-Sakellariou 1985, 297) provide a graphic depiction of the variety present in this group.

Beads of all three variants are characterized by a convex profile tapering to narrow ends. The variants differ greatly, however, in transverse section, which ranges from elliptical in variant A to fluted-round in variant C. The significant variation present in this group stems from a combination of the degree of flattening and the number and nature of longitudinal grooves. These grooves may be deep or shallow, narrowly or widely spaced, and vary from two to six on each face; depending on the combination, they may produce a few large, rounded gadroons or several sharp ridges.

Grain-of-wheat bead lengths vary due to the inconsistent tapering and frequent breaking of the beads' slender ends. Bead thickness also varies and, in some cases, is noticeably irregular, resulting in a lopsided transverse view. Flaws in these beads include elongated or misshapen ends, occasional cracking along the grooves of the longitudinal decoration and, rarely, transverse cracks along the bead edge.[74]

Although none of the beads retained its original surface, all beads studied show some trace of blue coloration. In KW 3947, although the bead exterior is dull and heavily eroded, a small patch of what appears to be turquoise glaze is visible just inside the perforation near one end. Both preservation of color, as well as intensity of staining, are stronger along the grooves in the beads; the ridges or gadroons, conversely, show heavier signs of attrition and, consequently, a more muted, powdery surface of a pale blue or gray hue. Discoloration is most often a light brown or red-brown color and occurs within grooves and near the bead ends.

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[74] These flaws will be discussed in light of bead manufacture in ch. IV.

The grain-of-wheat beads represent a Mycenaean bead type frequently encountered in LH III contexts; these beads are usually found in blue faience or glass and were sometimes covered with gold leaf.[75] The variation seen in grain-of-wheat beads at Uluburun is repeated at Dendra,[76] Menidi,[77] Prosymna,[78] and Mycenae,[79] where this type has been found in great numbers. Variant C, while a less common form, is represented at Argos[80] and Tiryns.[81] Grain-of-wheat beads of several variants are present at many other LH III sites on the Greek mainland.[82]

At Asine, a group of 41 faience or glass-paste and 38 gold grain-of-wheat beads were found along with several other jewelry items in a bronze jug,[83] which preserved the pattern of stringing:

> The beads had been arranged in two rows in such a way that two gold beads are always succeeded by two beads of glass-paste, but alternating in the two rows; two gold beads in the outer row thus correspond with two beads of glass-paste in the inner one, and vice versa. The total length of the necklace is about 0.60 m.[84]

The find at Asine provides evidence of necklaces composed solely of grain-of-wheat beads; although no gold grain-of-wheat beads were found at Uluburun, it is nevertheless possible that the faience grain-of-wheat beads formed two or more similar necklaces.

Nearly 50 beads of variants A and B from Panaztepe in western Anatolia are on exhibit at the Archaeological Museum in Izmir, and a grain-of-wheat bead found at

[75] Wace 1932, 206.
[76] Persson 1931, 30, no. 18, 39, Pit 1 no. 5, 106, nos. 47 and 48; Persson et al. 1942, 86, no. 32b.
[77] Deutsches Archäologisches Institut 1880, 12-3, pl. III.3.
[78] Blegen and Blegen 1937, 1:311.
[79] Wace 1923, 382, no. 4539; Wace 1932, 206; Xenaki-Sakellariou 1985, 297, nos. 47-48.
[80] Deshayes 1966, 32, no. DM 14.
[81] Haevernick 1981, 404, no. 20.
[82] These include Aidonia (Demakopoulou 1996, 66, no. 55), Elateia-Alonaki (Nightingale 1996, 144-7), Kalamaki (Lewartowski 1987, 128-9, no. 21), and Pylos (Blegen et al. 1973, 91).
[83] Frödin and Persson 1938, 398-400.
[84] Frödin and Persson 1938, 399.

Troy, although of a later date, is remarkably similar to Uluburun variant B in both form and dimension.[85] Grain-of-wheat beads were also found at the Dictaean Cave on Crete,[86] Pylona on Rhodes,[87] and Hala Sultan Tekke on Cyprus.[88]

Grain-of-wheat beads are less common along the Syro-Palestinian coast. The few faience examples found at Lachish date to the 14th century B.C. but are more finely made than those at Uluburun.[89] A solitary grain-of-wheat bead was found at Tell Abu Hawām.[90] The grain-of-wheat type corresponds with Petrie's type 122 at Gaza[91] and Riis' type 18 at Hama,[92] although the number of beads found at either site is unclear.

This type is scarce in Mesopotamia; at least one was found at Tell Brak,[93] and Beck likens some fragmented beads found at Nineveh to the grain-of-wheat type seen in the Aegean, although their date is uncertain and the fragments are not illustrated.[94] The grain-of-wheat bead type is virtually unknown in Egypt, although beads somewhat similar to Uluburun variant C have been found at Qua in Egypt and date to the First Intermediate period or Middle Kingdom.[95]

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85 This bead was found at Troy VIII but may predate this. (Blegen et al. 1958, 290, no. 36-59)
86 Boardman 1961, 73, nos. 343-344.
87 Karantzali 2001, 76-7, no. 680c.
88 Åström et al. 1983, 68, no. N 2020a.
89 Tufnell et al. 1940, pl. XXXV, no. 62.
90 Hamilton 1935, 61, no. 392 b.
91 Petrie 1932, pl. XXV, no. 122.
92 Riis 1948, 162, no. 18.
93 Oates 1987, 191, pl. XL.d.
94 Beck 1931, 430.
95 Brunton 1928, pl. CII, no. 80 D 18; Brunton 1930, pl. IV, no. 47 B 2.

<u>Biconical Beads</u>

The biconical faience beads at Uluburun comprise two distinct variants:

Variant A:
Inv. No. KW 1377 M12 UL4
Beck No. XXIII.A.3.d Perforation IV
Diam. 1.95 cm; length 0.99 cm; diam. of perforation 0.21 cm (molded face), 0.22 cm (incised face).
Length-to-diameter ratio: 0.51 (short)
Short faience bicone; decoration of 17 pronounced gadroons on one face and 17 incised lines on opposite face; the segments formed by the incised lines match the gadroons of the opposite face along bead perimeter, with one segment slightly off (fig. 2.11). Grayish blue with some pitting; light brown discoloration in pits and in incised lines of bead. Wear is heavier around perforation on gadrooned side. Perforation is approximately straight (plain).

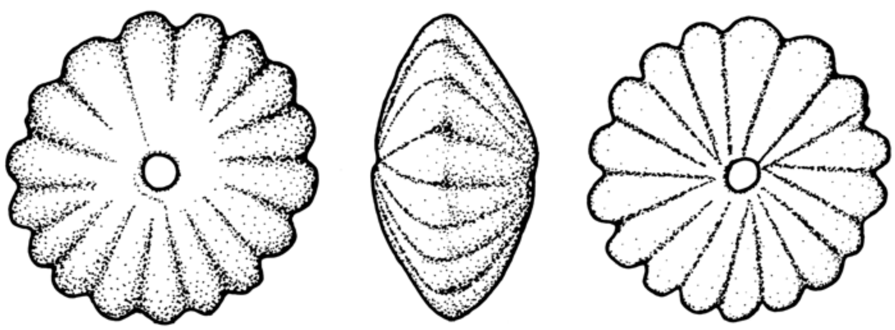

Fig. 2.11. Biconical variant A faience bead KW 1377. Scale 2:1.

Variant B:
Inv. No. KW 1595 M12 UL3
Beck No. XXIII.A.1.d Perforation IV
Diam. 1.83 cm; length 0.96 cm; diam. of perforation 0.31.
Length-to-diameter ratio: 0.52 (short)
Short faience bicone with 32 radial grooves on either face (fig. 2.12). Surface glaze completely eroded; blue hue barely visible among predominantly red-brown granular surface. Ridges between grooves radiate along bead perimeter at varying lengths producing a starburst effect, no longer present in some areas due to heavy erosion. Straight perforation.

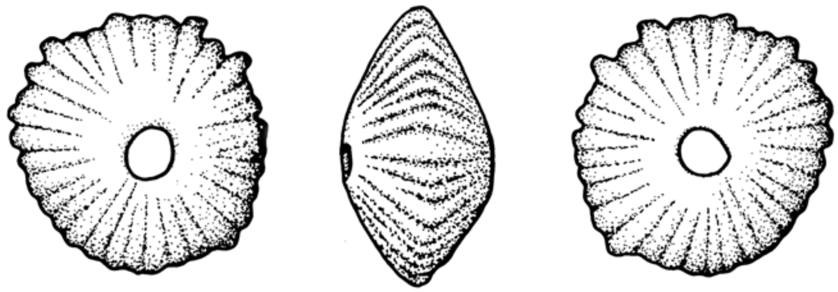

Fig. 2.12. Biconical variant B faience bead KW 1595. Scale 2:1.

54 biconical faience beads were found on the Uluburun shipwreck: 47 of variant A and only two of variant B; five beads are poorly preserved and of indeterminable variant. Average dimensions for biconical faience beads are as follows:[96]

Average diameter:	1.69 cm
Average length:	0.86 cm
Average perforation diameter:	0.24 cm

Both variants are short bicones alike in dimension and would appear similar when strung; they are, however, distinguishable by several characteristics. The variant A beads possess 17 gadroons of varying width on one face only, hereafter referred to as the molded face due to their likely means of manufacture. The reverse, hereafter referred to as the incised face, is shorter and is decorated with 17 radially incised lines forming segments similar to petals. These segments match the gadroons along the bead edge, albeit inaccurately in some beads, such as KW 1377; furthermore, some beads possess 16 rather than 17 incised segments. Although the number of gadroons is indeterminable on roughly one-third of the variant A bicones due to attrition, the

[96] For measurements and photographs of each bead, see app. B, 175-80.

remaining beads possess 17 gadroons without exception. Furthermore, the spacing pattern of gadroons on well-preserved beads is identical, indicating that these beads were made in the same mold.[97]

The level of preservation of the molded face varies from good to very poor. The incised face is, almost without exception, better preserved, in terms of both color and attrition. None of the variant A beads retain their original surface glaze; beads appear to be various shades of gray or blue, although all 52 beads appear blue when viewed under low magnification.

The two variant B bicones, unlike variant A, are radially grooved on either face. KW 1595, detailed above, exhibits 32 sharp grooves while KW 4177 exhibits 40. The resultant ridges radiate along the bead perimeter but are less pronounced in KW 4177. This may, however, be a result of attrition, as the latter is heavily eroded in sections along the perimeter and surrounding the perforation on one face. Both variant B bicones exhibit small patches of blue under low magnification, but are otherwise characterized by distinct red-brown coloration.

Faience bicones with radial decoration are common in both the Aegean and western Asia. It is, however, often unclear whether published parallels are more like variant A or B, and many beads seem to fall somewhere between the two. Nevertheless, I am not aware of any other beads that are molded on one face and incised on the other as are the beads of variant A. This may be a trait that was merely overlooked in other

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[97] The manufacture of these beads will be discussed in ch. IV.

published examples or may represent a unique aspect of the variant A beads at Uluburun. As a result, parallels presented here apply to both variants of radially decorated bicones.

Radially decorated bicones are common in Mycenaean cemeteries. They correspond to type 15 at Mycenae and were found in tholos and chamber tombs.[98] This type of bead was often covered in gold leaf,[99] as were two of the 30 such beads found in chamber tomb 2 at Dendra.[100] Two radially grooved bicones found at Aidonia exhibit the same distinct reddish-brown coloration, mottled with blue, seen on the variant B beads at Uluburun.[101] Other radially grooved or gadrooned bicones have been found at many sites on the Greek mainland.[102]

Radially grooved or gadrooned faience bicones are also well-known at LH III sites on both Crete[103] and Cyprus.[104] A chain composed entirely of such beads was found in a burial at Knossos,[105] and two similar chains of gadrooned bicones, but with central pendants, may be seen on a 6th-century B.C. terracotta statue of a female deity from Bayraklı near Izmir.[106]

This type of bead is commonly found at sites along the Syro-Palestinian coast. It corresponds to bead type 57, *disque lenticulaire avec sillons radiaires*, at Hama and

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[98] Xenaki-Sakellariou 1985, 294, no. 15; Wace 1923, 354-5, no. 91e-g, 357, no. 7, 382, no. 4540.
[99] Symeonoglou 1973, 70, no. 8.
[100] Persson 1931, 105, no. 44.
[101] Demakopoulou 1996, 66-7, no. 57.
[102] Other sites include Asine (Frödin and Persson 1938, 376, glass-paste no. 6), Elateia-Alonaki (Nightingale 1996, 146, no. V.2.B.a), Perati (Iakovidis 1980, 85, no. 15), Prosymna (Blegen and Blegen 1937, 1:308, no. 4), Pylos (Blegen et al. 1973, 204, no. CM. 2904), and Tiryns (Rudolph 1973, 49, no. 33).
[103] Effinger 1996, 24, no. 2.5.1.1 Variante B; Boardman 1961, 73, no. 346.
[104] Åström (1967, 49, no. 2b) provides a general overview of this type on Cyprus. Other Cypriot sites with decorated bicones include Athienou (Dothan and Ben-Tor 1983, 128, bead no. 10), Enkomi (Courtois 1984, 147, no. 1226), Hala Sultan Tekke (Åström et al. 1983, 66, no. N 2009a), and Salamis (Yon 1971, 21, no. 42).
[105] Evans 1906, 71-2, no. 66c.
[106] This statue is on exhibit at the Archaeological Museum in Izmir.

Woolley's type 17, spoked-wheel beads, at Alalakh, although the latter is presented as a disk rather than a short bicone.[107] Gadrooned bicones similar in dimension to the beads found at Uluburun have been found at Akko, Amman, and Lachish.[108] Similar beads also occur at sites further inland, such as Alishar Hüyük in the north and Tell Brak and Tell Zubeidi in the east.[109]

Like the grain-of-wheat beads, radially decorated bicones are scarce in Egypt. A group of 30 such beads, of red faience, were found at Gurob, but their context suggests that they represent possessions of a foreigner of Aegean or Cypriot origin.[110] Clay molds for faience found at Amarna include a large number of rosettes, some having the odd number of 17 petals seen on the variant A beads at Uluburun, and may have been used to produce biconical beads as well as inlay.[111]

<u>Grooved Barrel Beads</u>

Inv. No. KW 5472 N17 UL2
Beck No. XXIII.A.1.a Perforation IV, VIa
Diam. 0.64 cm; length 1.17 cm; diam. of perf. 0.18, 0.20 cm; diam. of end 0.37, 0.38 cm.
Length-to-diameter ratio: 1.83 (long)
Long faience barrel with 11 shallow grooves running from end to end (fig. 2.13). Grooves are unevenly spaced and exhibit minor variations in curvature due to convex bead profile. Pale blue in color with light brown staining on one side and darker brown staining appearing in decorative grooves. Glazed surface completely eroded; otherwise in excellent state of preservation. Medium-large perforation, approximately straight (plain).

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107 Riis 1948, 165, no. 57; Woolley 1955, 270, no. 17.
108 Arieh and Edelstein 1977, 26; Hankey 1995, 177, no. 5885d; Tufnell et al. 1940, pl. XXXV, no. 55; Tufnell 1958, pl. 29, no. 41.
109 Schmidt 1932, 1:275, no. b 2663; Oates 1987, 191, pl. XL.d; Boehmer and Dämmer 1985, 56, no. 545.
110 Petrie 1891, 17, pl. XVII, no. 26.
111 Petrie 1974, 30, pl. XVIII.

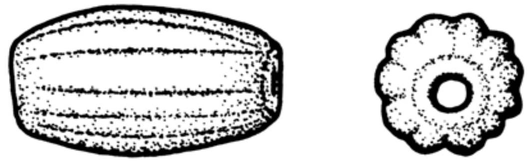

Fig. 2.13. Grooved barrel faience bead KW 5472. Scale 3:1.

Only 14 beads of this type were recovered from the shipwreck. These beads possess between 11 and 14 longitudinal grooves, which, with rare exception, run from end to end. Grooved barrel beads exhibit a long, convex profile terminating in flat, circular ends. The few beads in this group vary in degree of preservation. They are all blue in color but do suffer from some discoloration, especially within the incised lines. This group possesses the following average dimensions:[112]

Average diameter:	0.64 cm
Average length:	1.12 cm
Average perforation diameter:	0.20 cm
Average end diameter:	0.38 cm
Average number of incised lines:	12

This bead type, although less common than the grain-of-wheat type, is prevalent in Mycenaean contexts and corresponds to type 36 found in the chamber tombs at Mycenae.[113] Over a dozen grooved barrel beads similar to those at Uluburun were found at grave VIII at Prophitis Elias.[114] Ten similar beads at Elateia-Alonaki are somewhat

[112] For measurements and photographs of each bead, see app. B, 181-2.
[113] Xenaki-Sakellariou 1985, 296, no. 36.
[114] Rudolph 1973, 59, nos. 14 and 19.

longer and fusiform rather than barrel-shaped; however, Nightingale notes that each possesses between 11 and 13 incised lines.[115]

A grooved barrel bead of carnelian, similar in dimension to the beads at Uluburun, was found in the Montet Jar at Byblos.[116] Grooved barrel beads occur at other sites along the Syro-Palestinian coast, but, like those at Elateia-Alonaki, tend to be fusiform rather than barrel shaped.[117] Both fusiform and barrel forms occur at Amarna.[118]

Button Beads

Inv. No. KW 3481 L21 UL3
Beck No. XXIII.A.2.e Perforation IV
Diam. 1.06 cm; length 0.25 cm; diam. of depression around perforation 0.6 cm; diam. of perforation 0.22 cm.
Length-to-diameter ratio: 0.24 (disk)
Faience disk bead (fig. 2.14). On one face, perforation is set in a central depression, and bead surface is fluted between outer edge of depression and bead edge; reverse is flat and undecorated. Buff colored body with dark red-brown staining along one side of decorated face and across reverse; poor state of preservation. Original number of flutes indeterminable, possibly 16. Plain perforation.

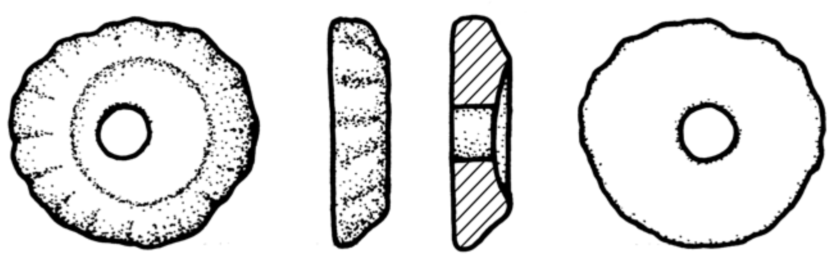

Fig. 2.14. Faience button bead KW 3481. Scale 3:1.

[115] Nightingale 1996, 144, no. IV.B.
[116] Montet 1929, 121, no. 552.
[117] Grooved fusiform beads have been found at Alalakh (Woolley 1955, 269, no. 9), Ugarit (Schaeffer 1962, 119, no. 18.104), and Lachish (Tufnell et al. 1940, pl. XXXV, no. 63).
[118] Frankfort and Pendlebury 1933, pl. L, nos. II and LXIII.

There are five beads of this type, only three of which are sufficiently preserved to allow detailed observation; the remaining beads deteriorated significantly after excavation.[119] These disk beads are difficult to classify and are notable for three distinct features: sloped fluting near the bead perimeter, a depressed center around the perforation, and a flat, undecorated back. All five have a buff colored body, on which the two better-preserved beads exhibit patches of dark reddish-brown coloration, notably in the fluting on KW 3443; none of the five exhibit any trace of blue coloration. Furthermore, all five are characterized by varying degrees of attrition, more advanced than that seen in other faience bead categories from the shipwreck. Based on their poor state of preservation and unique coloration, it is possible these beads may not be faience.[120]

They have been labeled as button beads due to their similarity to the base of typical Mycenaean shanked campaniform buttons, which have both a rolling edge and a concave depression around the perforation.[121] One such button found at Dendra exhibits a fluted edge as well.[122] Closer parallels to the Uluburun button beads exist in the various types of rosette disks found at Late Bronze Age sites throughout the Levant; such disks are gadrooned or fluted and have a flat back, but rarely exhibit the concave depression around the bead perforation. A faience bead found at Elateia-Alonaki in Greece exhibits the three features noted above but is unique at that site.[123] Another

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[119] For measurements and photographs of button beads, see app. B, 183.
[120] The coloration and consistency of these beads are clay-like.
[121] Blegen and Blegen 1937, 2:147, fig. 602. The diameter of Mycenaean shanked campaniform buttons is generally larger than that of the Uluburun button beads.
[122] Persson 1931, 41, no. 9.
[123] Nightingale 1996, 146-7, no. T LXVI/10s.

example with all three features was found in a tomb at Beth Pelet dated to the 19th Dynasty.[124]

Glass and faience rosette disks without the concave depression around the perforation are ubiquitous at sites in Egypt or under Egyptian influence, such as those along the southern Syro-Palestinian coast.[125] Yellow, gray, and dark red faience beads of this type were found with other types, including tiny and globular beads, near the neck of a body at a burial at Gurob in Egypt.[126] That such beads might have been strung on a necklace is somewhat surprising, as the rosette decoration would best be viewed in transverse rather than longitudinal view. Rosette disks of faience, commonly used as inlay, as well as the molds used in their manufacture, were found in large numbers at Amarna.[127]

In the Aegean, rosette disks are common but are often of gold, highly stylized, and pierced along the edges or longitudinally. Vertically pierced rosette disks have been found in limited numbers at Mycenae, Troy, and on Crete.[128] Examples on Cyprus have been found in both faience and bone.[129]

Although a few parallels for the button beads at Uluburun exist in the Aegean, these beads are more closely related to the stylistically Egyptian rosette disks found both in Egypt and the southern Syro-Palestinian coast. Both the small number found on the

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[124] Starkey and Harding 1932, pl. LXXII, no. S 50.
[125] Such disks have been found at Tell Abu Hawām (Hamilton 1935, 61, no. 392 b), Amman (Hankey 1995, 177, no. 5885g), Lachish (Tufnell et al. 1940, pl. XXXV, no. 47; Tufnell 1958, pl. 29, no. 42), and Gaza (Petrie 1932, pl. XXV, no. 71).
[126] Brunton and Engelbach 1927, pl. XLIII, no. 54 H.
[127] Petrie 1974, 28, pl. XVIII.
[128] Xenaki-Sakellariou 1985, 304, no. 89; Blegen 1958, 268, no. 38-41; Effinger 1996, 28, no. 2.5.1.12 Variante C.
[129] Åström et al. 1983, 68, no. N 2023a d; Vermeule and Wolsky 1990, 334, nos. T I.256 BI 4 and T II.84 BI 19.

ship and paucity in Mycenaean contexts suggests that these beads do not represent an item of cargo, but were rather personal belongings, possibly of a member of the ship's Syro-Canaanite crew.[130]

Melon Beads

Inv. No. KW 5174 M16 UR1
Beck No. XXIII.A.3.a (oblate melon bead) Perforation IV, VIa
Diam. 1.10 cm; length 0.69 cm; diam. of perforation 0.41 cm.
Length-to-diameter ratio: 0.63 (short)
Oblate faience spheroid with thirteen straight longitudinal gadroons extending nearly to bead ends (fig. 2.15). Original surface glaze not preserved. Body is yellowish-beige, slightly darker between gadroons, with traces of green coloration. Heavy attrition on parts of body; plain, medium-large perforation.

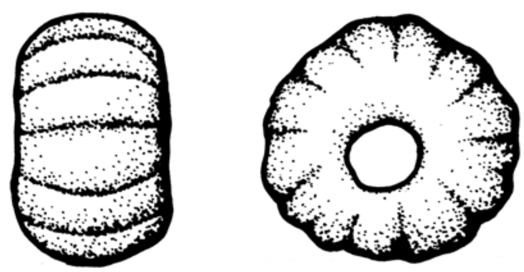

Fig. 2.15. Faience melon bead KW 5174. Scale 3:1.

This is the only bead of its kind found at Uluburun; as a longitudinally gadrooned spheroid it is classified as a melon bead,[131] so called due to this type's similarity to some fruits of the Cucurbitaceae (squash) family. This bead type enjoyed widespread popularity during the Bronze Age, and common materials include faience, glass, gold, and stones such as lapis lazuli, carnelian, or rock crystal. Melon beads may be fluted or

[130] Pulak 1998, 216-8.
[131] Beck 1981, 24, no. XXIII.A.3.a.

gadrooned; their form is similar in some aspects to both cogwheel beads and gadrooned bicones, and at times may be difficult to distinguish.

Melon beads are frequently found in Mycenaean contexts on the Greek mainland, where examples occur in faience, gold, and rock crystal.[132] The type is common in the tholos and chamber tombs at Mycenae,[133] and over 300 faience melon beads were found in chamber tomb 10 at Dendra.[134] Melon beads are a common form on both Crete and Cyprus.[135] A finely-carved melon bead of rock crystal was found on the Uluburun shipwreck and possesses fifteen gadroons, grouped into sets of three; this bead was probably strung on a necklace and may have been a personal possession of one of the high-ranking Mycenaeans aboard the ship.[136]

Examples in lapis and carnelian were found at the 3rd millennium B.C. Royal Cemetery at Ur,[137] and the melon bead style remained popular in Mesopotamia through the Late Bronze Age.[138] The type is found frequently in faience at sites along the Syro-Palestinian coast, from Alalakh to Gaza and numerous points between.[139] Faience was

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132 Deshayes 1966, 210, no. 6; Demakopoulou 1996, 53, no. 25a, 66, no. 56; Blegen and Blegen 1937, 1:308-9, no. 4.
133 Wace 1923, 382, no. 4540; Wace 1932, 72, no. 33; Xenaki-Sakellariou 1985, 292, no. 3.
134 Persson et al. 1942, 86, no. 32 a.
135 Effinger 1996, 25, no. 2.5.1.5 Variante B; Åström 1967, 48-9, bead type 1, fluted.
136 Bass et al. 1989, 8-9, fig. 16; Pulak (forthcoming), 10.
137 Woolley and Burrows 1934, 368, no. 14, 370-1.
138 Melon beads have been found at Tell Zubeidi (Boehmer and Dämmer 1985, 56, no. 544 A-B), Nineveh (Beck 1931, 429-30, no. 15), and Tell Brak (Oates 1987, pl. XL.c-d).
139 In addition to Alalakh (Woolley 1955, 269, no. 3) and Gaza (Petrie 1932, pl. XXV, no. 37), melon beads were found at Hama (Riis 1948, 164, no. 42), Tell Abu Hawām (Hamilton 1935, 61, no. 383), Megiddo (Loud 1948, pl. 209, no. 38, pl. 212, no. 53), and Lachish (Tufnell et al. 1940, pl. XXXV, nos. 50 and 54).

also the preferred material for melon beads in Egypt, and examples dating from the 18th-20th Dynasties have been found at several sites.[140]

Glass Beads

The excavation yielded a large number of wound glass beads of varying size. Of these, many were in such an advanced state of deterioration that they disintegrated in the process of excavation, often crumbling before reaching the surface. Still others had disintegrated completely, leaving only their impressions in encrustations.[141] As a result, it is difficult to state with certainty the actual number of glass beads carried on the ship at the time it sank; nevertheless, surviving artifacts suggest that at least 9,500 glass beads were on board, and the actual number carried was probably much higher. Due to their extended period underwater and the leaching out of various elements by the seawater, the present color of these beads no longer accurately reflects their original color. Unconserved beads (those still in water) retain the best color and are usually an opaque pale or yellowish green. Although the original coloration of the glass beads proved indeterminable through chemical analysis, Brill noted that a fragment of a small glass bead appeared to be light blue.[142]

The glass beads may be grouped into two categories based on size: small and large beads. Because many of the glass beads, especially the larger ones, are heavily

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[140] At Gurob (Brunton and Engelbach 1927, pl. XLV), blue faience melon beads were found strung with other beads of blue and green glass and carnelian. Melon beads were also found at Amarna (Frankfort and Pendlebury 1933, pl. L, no. LI), Kahun (Petrie 1891, 23, pl. XXVI, no. 16), Lahun (Petrie et al. 1923, pl. LXII, no. 47 H), and Badari (Brunton 1930, pl. XI, no. 83, pl. XXXII, no. 60).
[141] Pulak 1991, 6.
[142] Brill 1999, 1:48.

deteriorated, bead diameter is sometimes an unreliable means of classification. The bead cores in both categories, though, generally exhibit good preservation and, as a result, their diameter and length is at times the basis of categorization. In addition to a Beck number for classification, the classification based on the system outlined by Karklins will be provided.[143]

<u>Small Glass Beads</u>

Inv. No. KW 1550 L12 LR3
Beck No. I.B.1.a (spheroid) Perforation IV, VIa
Karklins No. WIb (wound beads)
Diam. 0.78 cm; length 0.67 cm; diam. of perforation 0.26 cm.
Length to diameter ratio: 0.86 (short)
One of two beads concreted to a bronze arrowhead (fig. 2.16). Intact, slightly oblate glass spheroid with evenly rounded perimeter. Although much of the surface is devitrified with some spallation, a large patch on one side is glassy and bright blue. Excellent state of preservation. Plain, medium-large perforation.

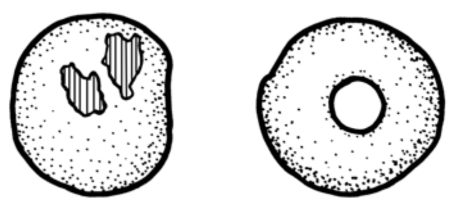

Fig. 2.16. Small glass bead KW 1550. Striated patches represent translucent blue coloration. Scale 3:1.

An estimated 9,000 small glass beads were found on the Uluburun shipwreck. Beads of this category are small, evenly formed spheroids, either spherical or just slightly oblate (class I.C.1.a or I.B.1.a). Striations perpendicular to the bead axis suggest

[143] The primary basis for Karklins' (1985) classification system is method of manufacture.

manufacture through winding and thus a Karklins classification of WIb.[144] Analysis of a sample of 100 small glass beads produced the following average dimensions:[145]

Average diameter:	0.76 cm
Average length:	0.60 cm
Average perforation diameter:	0.23 cm

Intact beads in this category generally exhibit a well-preserved surface with occasional surface spall. Devitrification, however, is predominant, and the translucent blue patches on the beads of KW 1550 are a rare exception. As a result of devitrification, the small glass beads are rendered opaque and exhibit a range of muted colors, including shades of yellow, brown, and light green. The majority of small glass beads, nearly 8,000, were found in a concreted lump inside Canaanite jar KW 8 (figs. 2.17 and 2.18).[146] Had this jar been filled to capacity with small glass beads, it would have held over 26,000 beads.

Bead form is generally well-preserved in this category due to the relatively infrequent occurrence of spallation. Whole and half beads as well as cores are commonly preserved within this group, the bead surface and core being the areas most resistant to deterioration. The cores possess an internal coating of a granular, opaque, beige substance, similar to clay, which may have contributed to their preservation; this also occurs in large glass beads. Some beads have deteriorated to the core shape with two lateral protrusions of the same length as the bead; this phenomenon, the cause of which is not fully understood, occurs more frequently in large glass beads.

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[144] Karklins 1985, 96-7.
[145] For measurements and photographs of each sample bead, see app. B, 184-92.
[146] The sample dimensions of beads as well as calculations to determine the number of beads present in KW 8 are provided in app. C.

Fig. 2.17. Concreted mass of small glass beads inside Canaanite jar KW 8.

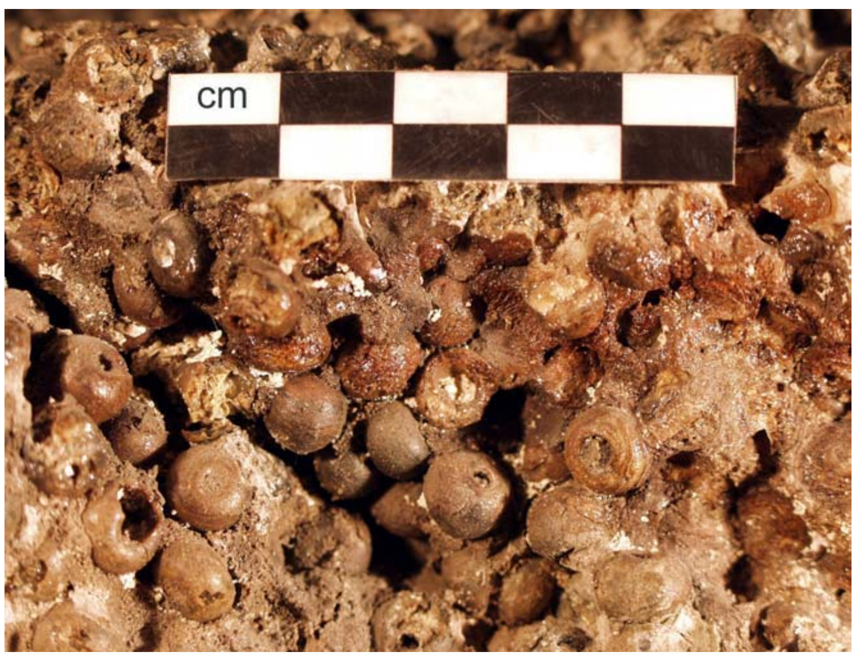

Fig. 2.18. Small glass beads inside Canaanite jar KW 8.

While most of the small glass beads possess a plain, or approximately straight, perforation, several beads possess a conical (Type III) perforation that is exceptionally small on one end or fails to penetrate the bead surface altogether (fig. 2.19). There is a possibility that a conical or incomplete perforation was intentional if these objects are pinheads rather than beads; glass pinheads found at Tell Abu Hawām exhibit similar incomplete perforations.[147] However, because the Uluburun glass beads with incomplete perforations were intermixed with other small and large glass beads, it is far more likely that this feature is a manufacturing flaw resulting from winding on a tapered mandrel.

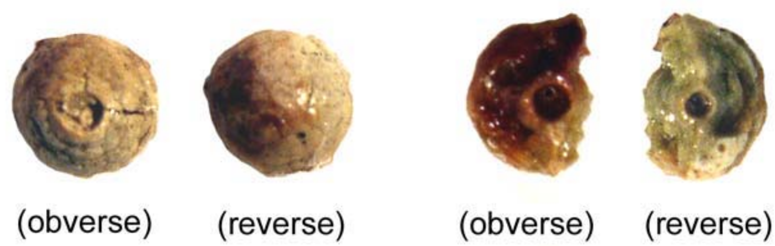

Fig. 2.19. Small glass beads from KW 1489 with incomplete or conical (Type III) perforations. Scale 3:1.

Contemporary parallels for the small glass beads have been found at several sites throughout the Levant. The preservation of such beads is often quite poor, causing the beads' original coloration to be replaced with opaque white, yellow, or gray.[148] Beads nearly identical to those found at Uluburun in both form and dimension were found in tomb XIX at Prosymna (97 beads)[149] and chamber tomb 524 at Mycenae (over 110 beads).[150] Similar small glass spheroid beads have been noted at numerous other sites on

147 Hamilton 1935, 62, no. 394 c.
148 Haevernick 1981, 407-8; Blegen and Blegen 1937, 1:297; Deutsches Archäologisches Institut 1880, 22.
149 Blegen and Blegen 1937, 1:298.
150 Wace 1932, 43, no. 31.

the Greek mainland,[151] Crete,[152] and Cyprus.[153] Close parallels were also found along the Syro-Palestinian coast at Lachish[154] and Tell Abu Hawām.[155] Factory waste at Amarna provides evidence of glass bead manufacture in Egypt,[156] and small blue glass beads were found at both Gurob[157] and Lahun.[158]

Several of the small glass beads found on the Uluburun shipwreck exhibit a striped surface in which bands of differing colors, usually light brown and cream, encircle the bead axis (fig. 2.20). The bands are very narrow and their boundaries often ill-defined. The multiple colors may represent intentional decoration or may result from varying rates of deterioration. Regardless of whether or not the striations were intended to be visible, their presence confirms manufacture through winding.

Glass beads decorated with spiral stripes have been found at several Late Bronze Age sites. However, this decoration is usually a thick white spiral contrasting a black or dark bead body, often a barrel rather than a spheroid; beads found on the Late Bronze Age shipwreck near Cape Gelidonya were decorated in this style,[159] as were beads found at Pylona on Rhodes[160] and Badari and Gurob in Egypt.[161]

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[151] Sites include Aidonia (Demakopoulou 1996, 56, no. 32, 66, no. 55), Dendra (Persson et al. 1942, 86, no. 32c), Elateia-Alonaki (Nightingale 1996, 142, no. I.A), and Tiryns (Rudolph 1973, 118).
[152] Evans 1906, 71-2, no. 66f.
[153] Åström 1967, 55, no. 1.
[154] Tufnell et al. 1940, pl. XXXIV, nos. 19-20.
[155] Hamilton 1935, 61-2, nos. 392 a, 394 a, and 399 b.
[156] Petrie 1974, pl. XIII, nos. 53-61.
[157] Brunton and Engelbach 1927, pl. XLV, no. 80 B.
[158] Petrie et al. 1923, pl. LXII, no. 80 N. Petrie (1890, 37), however, notes that glass beads are relatively uncommon in Egypt prior to the reign of Ramesses II.
[159] Bass 1967, 132, Type 1.
[160] Karantzali 2001, 74, no. 697a-c.
[161] Brunton 1928, pl. CII, no. 84 K; Brunton and Engelbach 1927, pl. XLIV, no. 73 N.

Fig. 2.20. Small glass beads from KW 1489 exhibiting cream-colored striations. Scale 3:1.

Closer parallels to the striped beads found at Uluburun occur at the contemporary site Tell Abu Hawām on the Syro-Palestinian coast, at which were found yellow and white spirally-striped glass beads and pinheads.[162] Glass beads with narrow white spiral stripes and zone decoration have also been found at several sites in Greece, although these beads tend to be much larger than those found at Uluburun.[163]

The archaeological evidence, then, shows that most Late Bronze Age spirally-striped beads are either larger than those found at Uluburun or incorporate wide bands of highly contrasting colors, often black and white. However, although the coloration on the striped glass beads found at Uluburun is more subtle, the current coloration is by no means representational of the beads' original appearance. Nevertheless, the small bead size and narrow stripes detract from the theory that the Uluburun beads were intentionally decorated with stripes and instead supports the idea that the striations represent characteristic deterioration of a wound glass bead.

[162] Hamilton 1935, 62, nos. 394 c and 395 a.
[163] Spirally striped beads have been found at Elateia-Alonaki (Nightingale 1996, 144, no. T XXIV/23c), Mycenae (Wace 1932, 73, no. 34 c-d), and Prosymna (Blegen and Blegen 1937, 1:298-300, no. 1). According to Beck (1981, 66), zone decoration is a line which meets and divides the bead surface into zones; it does not apply to spiral lines. The images of beads from Prosymna, however, suggest that Blegen is using the term to describe both spiral lines and true zone decoration.

At least seven segmented glass beads were found on the Uluburun shipwreck; the dimensions of these beads are roughly consistent with those of two conjoined small glass beads. The segmented glass beads always possess two segments joined end-to-end and sharing a single axis. In some, the two beads are nearly separated, exhibiting a deep score that does not meet but produces a Z-shaped line around the middle of the bead. Other segmented beads do not exhibit a distinct score but are slightly pinched. Both types are illustrated in figure 2.21.

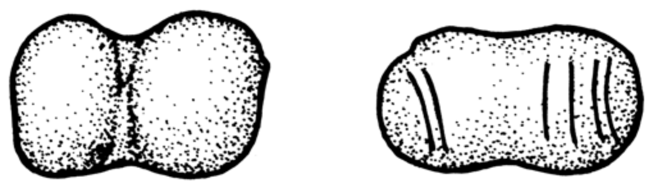

Fig. 2.21. Segmented glass beads from KW 1489, the bead on the left exhibiting the Z-shaped score mark. Scale 3:1.

A similar segmented glass bead from Cyprus has been published,[164] and such beads, although rare, are present along the southern Syro-Palestinian coast and in Egypt. A group of spherical glass beads from Tell Abu Hawām contains at least one segmented bead similar to those found at Uluburun; this bead consists of two conjoined spherical glass beads and exhibits a small peak at one end.[165] Similar glass beads were found in larger numbers at Lachish.[166] Segmented glass beads with two segments were found at Amarna and may represent a distinct bead style;[167] however, evidence also shows that

[164] Karageorghis and Demas 1985, 151, pl. CXXXIV, no. 4511.
[165] Hamilton 1935, 61, no. 392 a.
[166] Tufnell 1958, pl. 29, no. 28.
[167] Frankfort and Pendlebury 1933, pl. L, no. XXXIX.

similar segmented beads represent factory waste from the glass bead-making industry at the site.[168] This factory waste includes conjoined beads with slight indents as well as those with partial scoring between beads. Similar conjoined beads of green and brown glass at Gurob are described as “irregular” and no doubt represent beads flawed during manufacture, specifically beads formed in multiples that were not broken apart as intended.[169]

If the Uluburun segmented glass beads are understood as unfinished pieces, the Z-shaped scoring visible on some beads is actually a line along which the beads were to be broken. Support for this theory may be found in some single glass beads at Badari in Egypt.[170] These beads, of blue and yellow glass, exhibit distinct peaks at either end, in opposing directions; if a series of beads (three or more) was formed in this way, scored similarly to the segmented bead in figure 2.21, then broken apart, the resultant beads would exhibit just this feature. The similar peak on the segmented glass bead at Tell Abu Hawām provides further support for this theory. With this in mind, it seems more likely that the few segmented glass beads at Uluburun represent manufacturing flaws rather than a distinct style of bead.

[168] Petrie 1974, pl. XIII, nos. 57 and 60.
[169] Brunton and Engelbach 1927, pl. XLIII, no. 58 L.
[170] Brunton 1930, pl. XXXII, nos. 55-56.

<u>Large Glass Beads</u>

Inv. No. KW 2673	L20 UL2
Beck No. I.B.1.a	Perforation III, VIa

Karklins No. WIb (wound beads)
Diam. 1.25 cm; length 0.78 cm; diam. of perforation 0.38, 0.35 cm.
Length-to-diameter ratio: 0.62 (short)
Large, oblate glass bead (fig. 2.22). Dark, devitrified surface, original coloration or decoration indiscernible. Edge between bead end and perforation (0.35 cm) is rounded and indistinct at one end, and forms an angle at opposite (0.38 cm) end. Medium-large, slightly conical perforation.

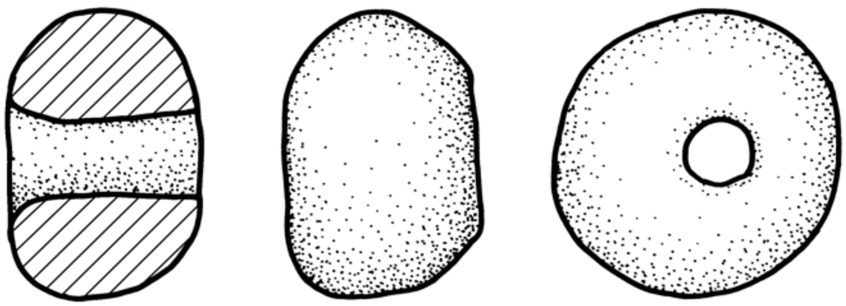

Fig. 2.22. Large glass bead KW 2673. Scale 3:1.

The beads in this category are both significantly larger and less uniform than the small glass beads. Approximately 500 large glass beads were found on the Uluburun shipwreck, although many more were likely present on the ship. They are classified as I.B.1.a or I.C.1.a and are generally spheroid, although some are too squat to be classified as such. These beads are often lopsided and frequently exhibit a small peak at one end, suggestive of manufacture through winding and thus of Karklins classification WIb. Analysis of a sample of large glass beads produced the following average dimensions:[171]

Average diameter:	1.25 cm
Average length:	0.83 cm
Average perforation diameter:	0.40 cm

[171] For measurements and photographs of each sample bead, see app. B, 193-205.

The large glass beads show greater deterioration than do the small glass beads; those that are intact are characterized by devitrification which has resulted in the loss of the bead's original color. Resultant coloration is usually a combination of muted shades of gray, brown and red but may also include yellow and light green. Additionally, many large glass beads suffer from extensive surface spallation, effectively destroying the bead surface and precluding accurate measurements.

Many of the better preserved beads in this category exhibit two cracks, one on either side of the perforation at either end. These cracks may be visible only near the perforation, or may run the entire length of the bead, at times splitting it in two. Poorly preserved beads consist only of the core and two lateral projections in the same position as the aforementioned cracks (fig. 2.23), also noted in the small glass beads. The cores, like those of the small glass beads, are coated with an opaque, beige substance (fig. 2.24), which may be responsible for their state of preservation; it is unknown, however, why the lateral projections show such excellent preservation.

Fig. 2.23. Two large glass beads from Lot 9855 exhibiting a preserved core with lateral cracks and projections. Scale 3:1.

Fig. 2.24. Large glass bead from Lot 9855 with a beige substance coating the inner walls of the perforation. Scale 3:1.

The intact large glass beads analyzed exhibit a gradual rounding from one bead end into the perforation, while the opposite end forms a distinct angle at the perforation; this is visible in the longitudinal section of KW 2673 (fig. 2.22). Although the perforation of these beads is generally straight, subtle differences in perforation size occur, with the larger perforation occurring at the angular rather than rounded end.[172]

Parallels for these large glass beads have been found throughout the Late Bronze Age Levant, although such beads are frequently in a poor state of preservation. Lateral cracks similar to those observed on the beads found at Uluburun are visible on large glass beads found at Late Bronze Age sites in Greece such as Argos[173] and Prosymna.[174] Some large glass beads from Tiryns are lopsided, again suggesting manufacture through winding.[175] Further parallels have been found at several other sites on the Greek mainland.[176]

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[172] This characteristic is discussed in light of manufacture technique in ch. V.
[173] Deshayes 1966, 71, no. DM 39, pl. LXX, no. 9.
[174] Blegen and Blegen 1937, 1:298-301, esp. beads from tomb XXXVI.
[175] Haevernick 1981, 404, nos. 4 and 4a; Rudolph 1973, 48-9, nos. 29 and 34, 54, no. 24.
[176] Parallels for the large glass beads were also found at Aidonia (Demakopoulou 1996, 56, no. 32), Dendra (Persson et al. 1942, 29, no. 23, 86, no. 32 c-d), Mycenae (Wace 1932, 25, no. 36 d, 73, no. 34 d), and Pylos (Blegen et al. 1973, 195, no. CM. 2900, fig. 250, no. 19).

As with the small glass beads, large spheroid glass beads are abundant at sites on Cyprus[177] and the Syro-Palestinian coast.[178] Glass beads found at Kāmid el-Lōz are very similar to those found at Uluburun, exhibiting both lateral cracks and a lopsided profile.[179] Lateral cracks are again visible on beads from Tell Abu Hawām.[180] Finally, a greenish-blue glass bead was found at Stratum IV at the Anatolian site of Alishar Hüyük (1400-1200 B.C.) and exhibits a white coating inside its perforation.[181]

Large glass beads are also present in Egypt, and misshapen beads comprising factory waste at Amarna exhibit some of the traits seen on large glass beads found at Uluburun, such as a peak at one end and a lopsided profile.[182] Oblate spheroids in green and blue glass are also noted at Gurob.[183]

Some of the well-preserved Uluburun large glass beads are recognizable as eye beads, which are beads possessing spots or "eyes" of a different color of glass applied to the original glass matrix (fig. 2.25). This type of bead probably served as an amulet for protection against the evil eye.[184] Although eye beads can be manufactured using a number of different materials and methods, these particular eye beads are classified as simple spot glass eye beads. [185] Simple spot glass eye beads utilize two colors of glass:

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[177] Åström 1967, 55, no. 1, 124; Karageorghis and Demas 1985, 151, nos. 4513 and 4744+4748, 232-3, nos. 1984-1993 and 2001-2220; Dikaios 1969, 252.
[178] Glass beads similar to those at Uluburun were found at Lachish (Tufnell et al. 1940, pl. XXXIV, nos. 14, 16, and 21) and Megiddo (Loud 1948, pl. 210, no. 45).
[179] Miron 1990, 107, nos. 493-495.
[180] Hamilton 1935, 61-2, nos. 385, 392 a and 394 a.
[181] Schmidt 1932, 1:275, no. b 2597.
[182] Petrie 1974, 27, pl. XIII, nos. 53-58.
[183] Brunton and Engelbach 1927, pl. XLV, no. 79 H, X.
[184] Gifford 1958, 67-8.
[185] Beck 1981, 42, no. XLVI.A.2.b(1); Eisen 1916, 4-5.

that of the matrix or bead body, and that of the spots, drops of glass which are applied then marvered or heated to lie flush with the bead surface.

Fig. 2.25. Simple spot glass eye beads from Lot 9855. Scale 3:1.

Unfortunately, surface devitrification and discoloration often obscure the presence of spots or eyes. It is not clear, therefore, whether or not all large glass beads found on the Uluburun shipwreck are eye beads, although this is certainly a possibility; it can only be definitively stated that some of the large glass beads are eye beads. The number of eyes on each eye bead varies between one and four, although eyes may sometimes be irregular, seemingly formed of two drops of glass. They are always located on or near the bead equator and may be any shade of off-white or yellow.

Color alone, however, is not the sole method available for identifying an eye bead. Eisen, in discussing eye-ring beads dating from the 9th to the 5th centuries B.C, noted that many rings had dropped out of the bead, leaving a hollow imprint where they once were.[186] The same phenomenon may be observed in some of the eye beads found at Uluburun. Some beads do not retain eyes but possess pits approximating the size and

[186] Eisen 1916, 12. The eye-ring bead is one in which a ring of glass of a different color is impressed into the glass matrix.

shape of eye spots (fig. 2.26); other beads possess both eyes and pits, the pits occurring in approximately the same size and location as the eyes on complete beads. Although Eisen attributes this phenomenon to poor manufacture, it may more appropriately be attributed to differing coefficients of expansion of the colored glasses used.

Fig. 2.26. Simple spot glass eye bead from Lot 9855 with large pits approximating the size and shape of eye spots. Scale 3:1.

Although eye beads have been found at Late Bronze Age sites, they are relatively uncommon, and few thereof provide close parallels for those found at Uluburun. A simple spot glass eye bead was found at in a LH IIIC context at Tiryns.[187] 19 yellow beads with three white eyes each were found in Tomb 526 at Mycenae; however, the eyes are much larger and were applied as spirals rather than drops.[188] If the cargo of the Uluburun shipwreck was originally destined for somewhere in the Aegean, it is surprising that more eye beads have not been found there. However, as previously noted, glass beads in this region suffer significant deterioration due to the environment,

[187] Haevernick 1981, 404, no. 6.

[188] Wace 1932, 94, no. 7b, 208. Haevernick (1981, 408) suggests that the spiral eyes seen on the eye beads at Mycenae are actually stratified eyes rather than spirals, and that this comprises a common type in the Late Mycenaean period.

most often obscuring the beads' original surface. Flush-spot eye beads, then, may have been found in larger numbers than publications suggest, but may simply not be recognizable as eye beads due to poor preservation.

Simple spot glass eye beads as well as some with double stratified pupils were found at Kition,[189] although the type does not appear frequently on Cyprus. Glass eye beads found at Lachish provide perhaps the best parallel for those found at Uluburun; these beads are of similar dimension and form and possess eye spots that are irregular and overlapping.[190] A similar bead was found in a tomb at Beth Pelet dated to the 19th Dynasty,[191] and several types of eye beads of uncertain date were found at sites further inland.[192] Finally, although eye beads and pendants are common in Egypt, they tend to possess stratified rather than simple spot eyes.[193]

Instead of rounded eyes, some of the large glass beads from the Uluburun shipwreck possess flush, yellow and white spots that are both smaller and more angular than those of the traditional spot eye beads (fig. 2.27). This type of bead, a glass crumb bead, is also considered a form of simple glass eye bead.[194] To create a flush glass crumb bead, a hot bead is either rolled in or sprinkled with glass crumbs of one or more

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[189] Karageorghis and Demas 1985, pl. CCXXVIII, no. 2045, pl. CCXXXIX, no. 1988.
[190] Tufnell 1958, pl. 29, no. 48.
[191] Starkey and Harding 1932, pl. LXXII, no. K 13.
[192] A variety of eye beads dated loosely to Stratum V were found at Alishar Hüyük in Anatolia (Schmidt 1933, 2:84-5).
[193] Black and white stratified glass eye beads of 22nd-24th-Dynasty date were found at Lahun (Petrie et al. 1923, pl. LXII, no. 58 D). In addition to several types of eye pendants, flattened, stratified eye beads with yellow, black and white were found at Gurob (Brunton and Engelbach 1927, pl. XLIII, no. 58 A-E). Other eye beads of New Kingdom date were found at Qua and Badari, although these tend to be smaller and of different form than the beads found at Uluburun (Brunton 1930, pl. XXXII, nos. 45-46, 57, 59).
[194] Beck 1981, 42, no. XLVI.A.2.d.

colors, then rolled on a marver to press the crumbs into the bead matrix.[195] This method of manufacture frequently results in smaller spots with irregular corners in contrast to the rounded spots of a glass spot eye bead.[196] Furthermore, the spots on a glass crumb bead are characterized by random placement and often overlap.[197] However, it is important to note that many of the large glass eye beads found on the Uluburun shipwreck appear to possess both rounded spots and smaller, irregular crumbs.

Fig. 2.27. Glass crumb bead from Lot 9855. This bead possesses both large white spots and smaller yellow crumbs. Scale 3:1.

Close parallels for these beads were found at the Mycenaean cemetery at Pylona on Rhodes, where three spherical glass beads were decorated with crumbs of red, white, yellow and gray.[198] Another, albeit abnormally large, crumb bead was noted at Elateia-Alonaki;[199] this style is, however, uncommon in the Aegean during this period. Faience crumb beads of earlier date have been found in both Mesopotamia and Egypt; due to

[195] Beck 1981, 62-3.
[196] Eisen 1916, 5.
[197] Beck 1981, 42.
[198] Karantzali 2001, 74, no. 695 a-c.
[199] Nightingale 1996, 144, no. T 16/69.

their infrequency in Egypt, however, they are considered a foreign import.[200] The black glass barrel or drop beads with white spots at Gurob provide a closer parallel,[201] and a glass bead found at Kāmid el-Lōz with spots of white, yellow and black may represent a crumb bead.[202] The scant archaeological evidence for crumb beads during the 14th century B.C. may suggest that such beads did not comprise a popular style. However, as noted for the simple spot glass eye beads, if the bead surface is poorly preserved, there may be no trace of flush spot or crumb decoration remaining on a bead. Crumb beads may, then, be present in far greater numbers than is actually suggested in publication.

[200] Beck 1931, 430; Brunton 1928, 20.
[201] Brunton and Engelbach 1927, pl. XLIV, no. 70 R, pl. XLV, no. 276 A.
[202] Miron 1990, 107, no. 492.

CHAPTER III

DISTRIBUTION

While archaeological context is to a large extent established by the shipwreck itself, the location of each bead on the wreck potentially holds information on its use, containment, and relation with other beads. Of primary interest is determining which faience and glass bead categories may be designated an item of cargo. Bead concretions KW 8 (small glass beads) and KW 76 (tiny faience beads) provide direct evidence that beads of this kind were carried in bulk quantities and therefore represent elements of cargo. However, this is less easily determined in other faience and glass categories, and a designation of cargo or personal possession is often based on indirect evidence in the form of style, number of beads, and presence of manufacturing flaws.

An additional form of indirect evidence lies in each category's distribution on the wreck site. In order to create comparable artifact distribution patterns, each faience and glass bead category was digitally plotted on the wreck's site plan using field data. During excavation, the site was organized into one meter grid squares, which were divided into upper left (UL), upper right (UR), lower left (LL), and lower right (LR); each of these four sections was further divided into four subsections as shown in figure 3.1.[1] Each KW or lot number's location is designated by a six-digit alphanumeric code; the first three digits designate the grid square and the last three correspond to the subsections as described above.

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[1] Lin (2003, 15) provides further information on the creation of the ship's site plan.

The ship came to rest on a steep slope in an east-west orientation; a concentration of stone anchors toward the eastern or downslope end suggests the location of the bow.[2] The distribution of artifacts and orientation of hull material further suggest that the ship listed 15° to starboard.[3] The intensity of the slope (30 to 45 degrees), combined with the starboard list, produced artifact scatter diagonally to the southeast or simply downslope rather than directly to starboard (south).[4] Furthermore, three significant artifact shifts occurred over time, complicating the interpretation of artifact distribution patterns.[5]

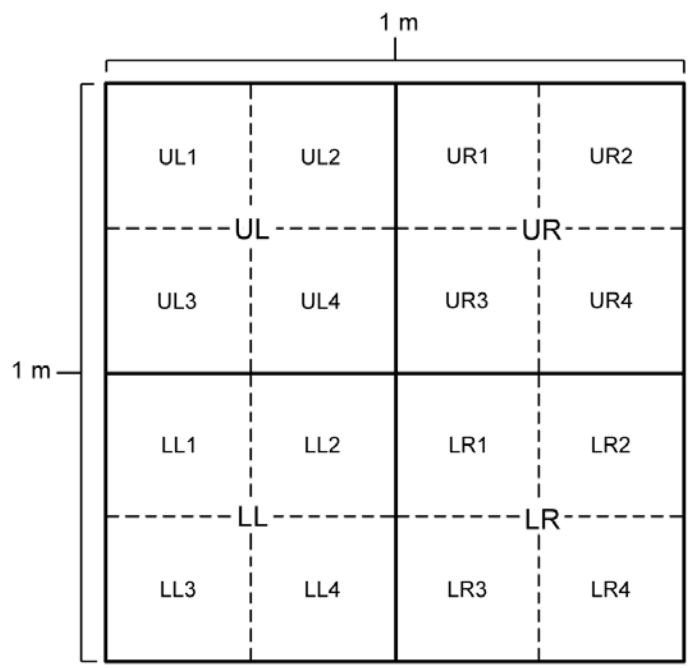

Fig. 3.1. Layout of a one-meter grid square at Uluburun.

[2] Pulak 2002, 615.
[3] Bass 1986, 270; Pulak 2002, 615.
[4] Pulak 1991, 5; Lin 2003, 34.
[5] Pulak, personal communication; Lin 2003, 26-7.

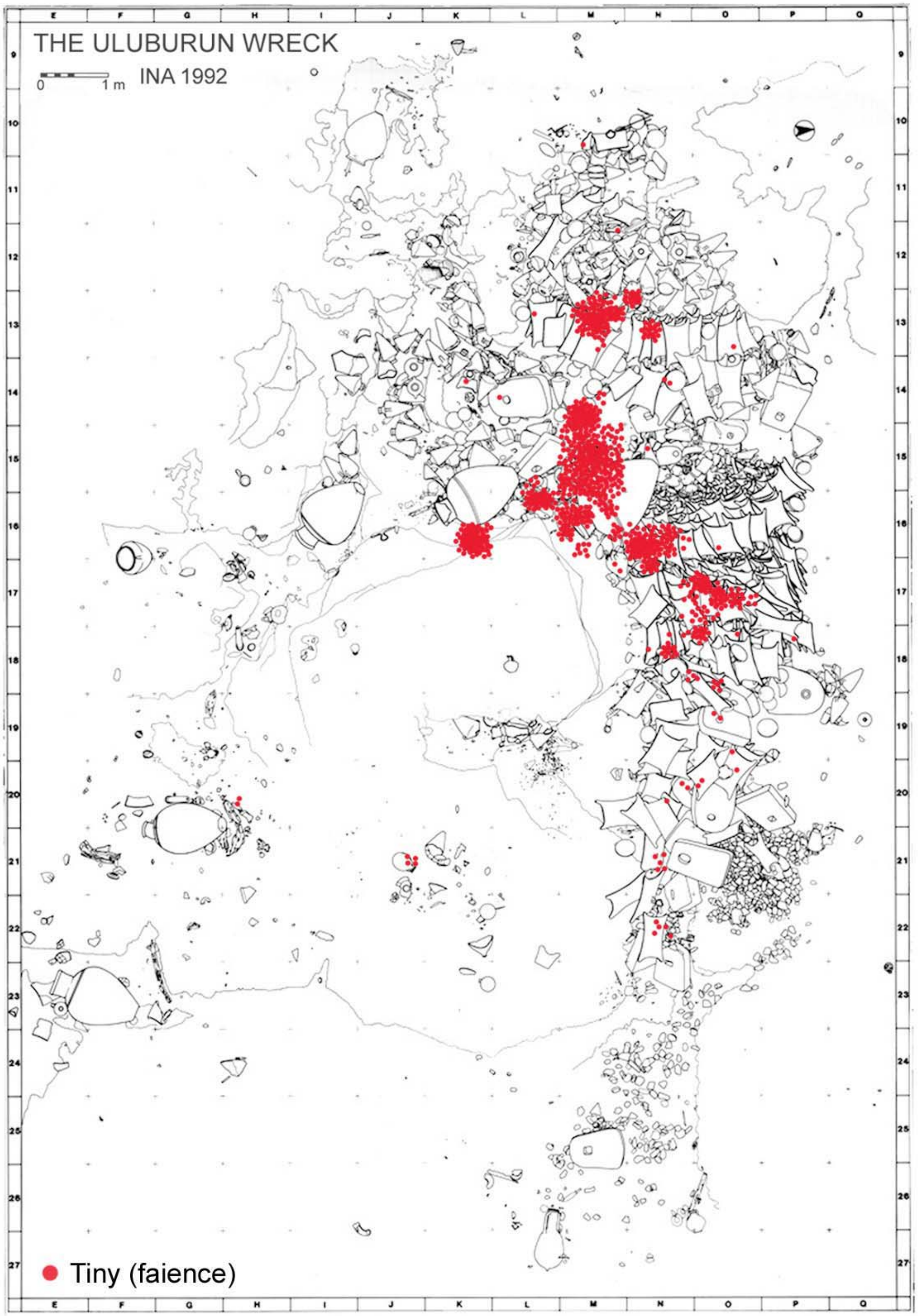

Fig. 3.2. Distribution of tiny faience beads on the site plan. (After Pulak 1998, 192, fig. 4)

Faience Beads

The tiny faience beads (fig. 3.2) were most heavily concentrated around the large rock outcrop near the center of the wreck. Distinct clusters were found in squares K16, M13, M14-16, N16 and O17, with additional beads sparsely scattered throughout the wreck site, primarily eastward.[6] These beads show a greater range of distribution than do the other faience bead categories, a circumstance easily explained by their slight nature. Although the pattern of heavy concentration toward the center of the wreck recurs with both globular and cogwheel faience beads, the tiny faience beads comprised a larger number of smaller concentrated pockets. This may be due to transport in multiple receptacles or may merely be a result of drift.

The concentration at M14-16 included KW 76, a concreted mass of at least 68,000 tiny faience beads.[7] While tiny faience beads usually exhibit variation in size and color, beads in this concreted mass are consistently 0.21-0.31 cm in diameter and 0.10-0.17 cm in length; bead color is indiscernible. This concretion was not found in association with a Canaanite jar; furthermore, although of amorphous shape, the concretion exhibits a distinct flattened oval on one side, suggesting storage in a bag which kept the group reasonably intact.

The globular faience beads (fig. 3.3) were concentrated in square N16, with smaller pockets surrounding this area to the northeast and southwest. In addition to

[6] One tiny faience bead, not shown in fig. 3.2, was recovered from square K30, where it was found inside a Canaanite jar.
[7] This number represents a conservative estimate. Calculations to determine the number of beads present in this concreted mass are provided in app. C.

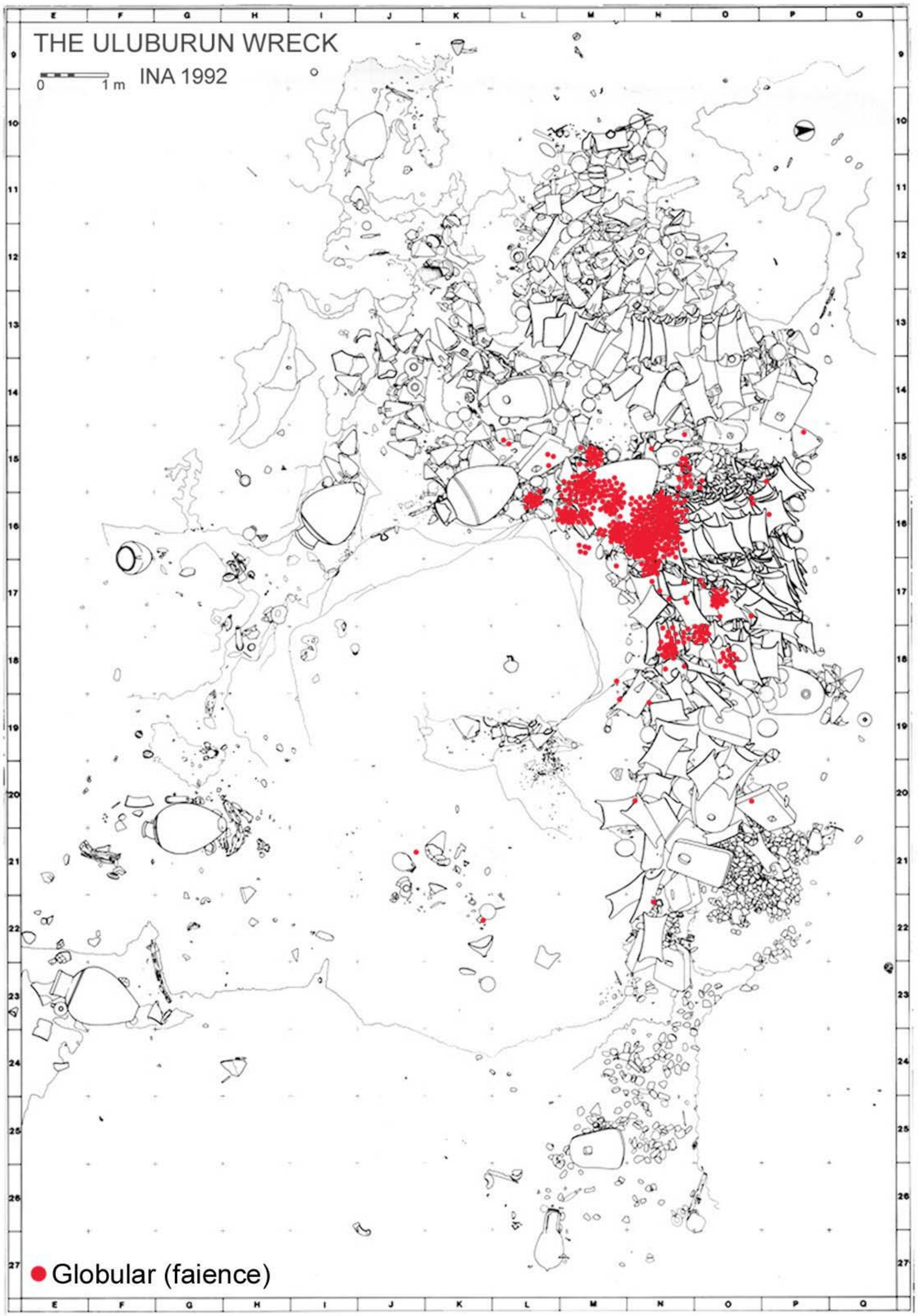

Fig. 3.3. Distribution of globular faience beads on the site plan. (After Pulak 1998, 192, fig. 4)

sharing a distinct concentration in square N16, the tiny and globular faience beads both formed small clusters in squares L16, M15-16, and O17.

As illustrated in figure 3.4, the cogwheel faience beads were concentrated in square M16, near the large rock outcrop at the center of the wreck. Starting just southwest of M16, the distribution pattern forms a northeastern arc, becoming sparser toward the eastern end of the site. The heavy concentration of cogwheel beads in and around square M16 coincided with a concentration of tiny faience beads and a smaller pocket of globular faience beads.

The collared cogwheel beads were mapped separately to analyze their relationship to the plain cogwheel faience beads. If considered a different category than the plain cogwheel beads, their small number and more intricate design suggest that the collared cogwheel beads were personal belongings rather than elements of cargo. However, mapping this subcategory showed that its distribution closely matches that of the plain cogwheel beads. Although they are not concentrated in any particular area, the collared cogwheel beads follow the same northeastern arc from just southwest of square M-16 to the eastern end of the wreck. These patterns suggest that the collared and plain cogwheel beads were shipped in close association.

The grain-of-wheat variant A faience beads (fig. 3.5) lay scattered across the eastern half of the wreck, with the heaviest concentration toward the bow of the ship in square N-20; no grain-of-wheat beads were present on the western half of the wreck. One variant A bead was found in a small group with four variant B beads in square K30 at the extreme eastern end of the site. Of the 153 beads of this variant recovered, 86, or

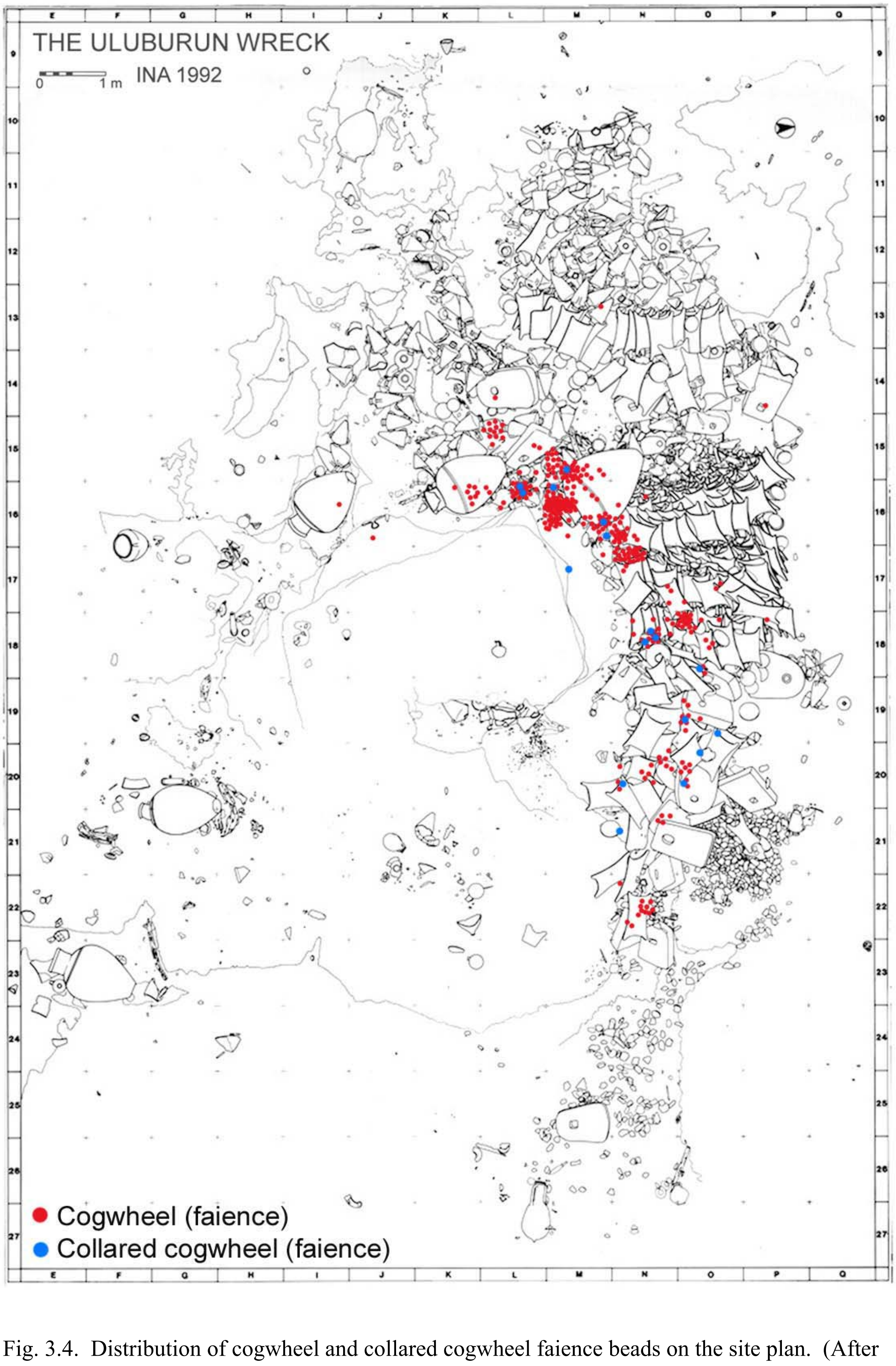

Fig. 3.4. Distribution of cogwheel and collared cogwheel faience beads on the site plan. (After Pulak 1998, 192, fig. 4).

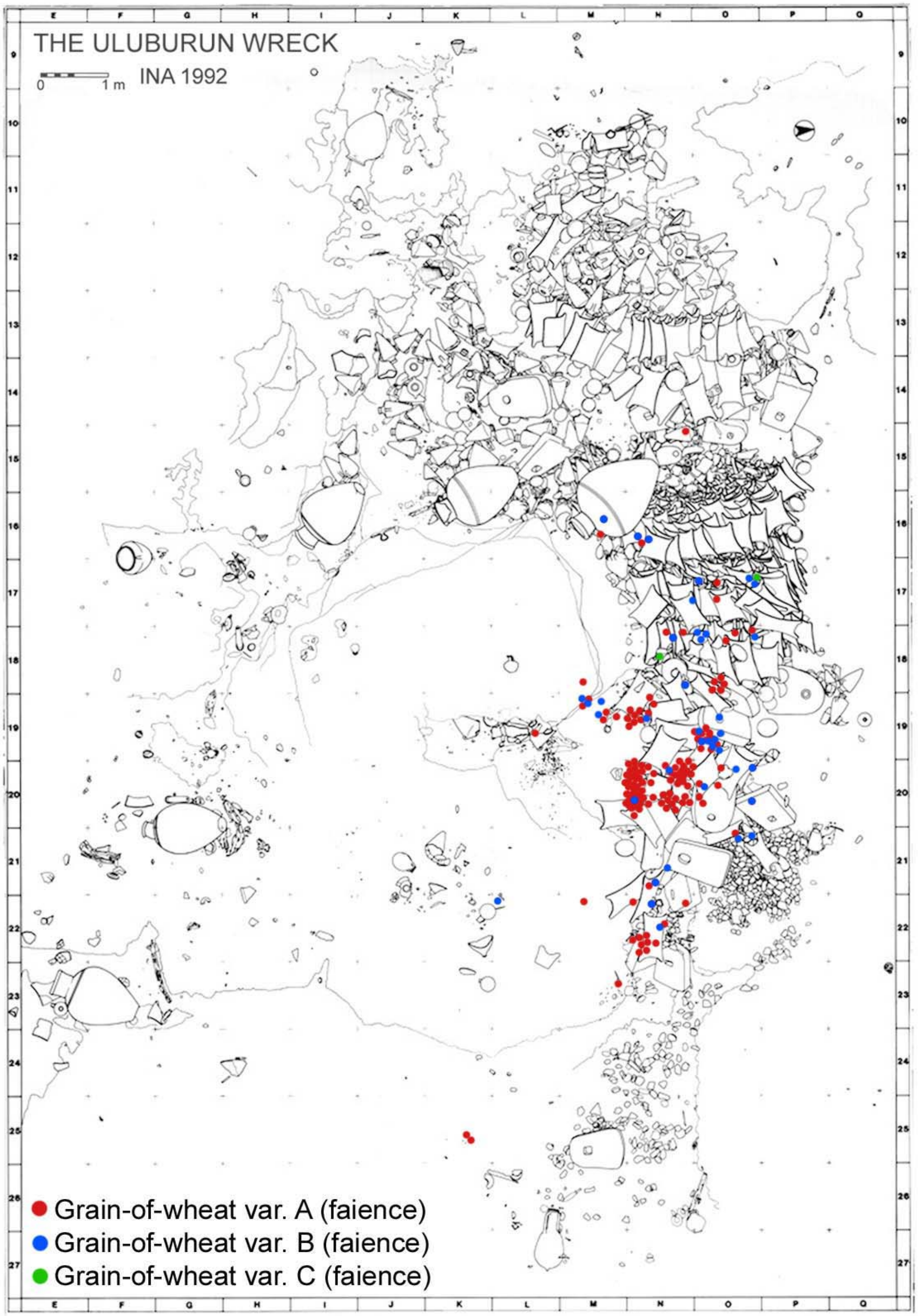

Fig. 3.5. Distribution of grain-of-wheat faience beads on the site plan. (After Pulak 1998, 192, fig. 4)

56%, were located in square N20. Within this square, there was a dense concentration of 50 variant A beads, representing 33% of the entire variant, in a 25 by 75 centimeter area (N20 UL1, UL3, and LL1).

Grain-of-wheat variant B comprises 22% of the grain-of-wheat category, and its distribution matched that of variant A with one significant exception: only two grain-of-wheat variant B beads were found in the variant A concentration in square N20. The two variant C grain-of-wheat beads were found in N18 and O17 UR4, fitting the loose distribution of variant A and B beads in that area.

The distribution of the grain-of-wheat beads as a whole is exceptional in that its heaviest concentration was toward the bow of the ship, with some downslope scatter (15%) but a much more significant upslope scatter (over 25%). This, combined with the uneven distribution of the grain-of-wheat variants, suggest that these beads were carried in at least two separate groups. The hypothesis that these beads were personal belongings that were strung is well supported on stylistic grounds. However, if all beads of this category were strung, they would have formed a single strand over 250 cm long. From this standpoint it seems likely that the beads formed two or more strands, thereby explaining both the irregular distribution of variant A as well as the illogical upslope scatter.

The sparse distribution of cogwheel beads towards the eastern end of the wreck seems to align with the heaviest concentration of grain-of-wheat beads, which might suggest that a separate group of cogwheel beads was strung or carried in association with the grain-of-wheat beads. However, the presence of collared cogwheel beads throughout the distribution of plain cogwheel beads, both within and without the range of grain-of-wheat beads, suggests that the overlapping pattern is merely a result of coincidental drift.

The variant A (gadrooned) biconical faience beads (fig. 3.6) were loosely distributed on the western half of the wreck with three isolated beads to the southeast near pithos KW 254 in G20-21 and two additional beads just east of the middle of the wreck in N18 and O17. The variant A bicones were found most often at the stern, in or near L11, although a distinct concentration is lacking. Variant B (radially grooved) bicones KW 1595 and 4177 fit the distribution of variant A beads (fig. 3.6); this, and their similarity in longitudinal view suggest that the two were carried or strung together. The distribution pattern for the grooved barrel faience beads, also illustrated in figure 3.6, closely follows that of the bicones. Like the variant A bicones, the grooved barrels were scattered loosely on the western half of the wreck. One isolated grooved barrel lay near the three isolated variant A bicones toward pithos KW 254, and another three grooved barrels lie near the other two isolated variant A bicones in N-O17. The distribution patterns formed by these two bead categories are inconsistent with that of any other faience or glass bead category; the uniqueness of this pattern, combined with their small number and sparse distribution, suggest they were carried together and may possibly have been strung together.[8] The solitary melon bead might also be linked to the bicones and grooved barrels, but was found near the center of the wreck and potentially fits any distribution pattern discussed thus far.

[8] If the bicones and grooved barrels were indeed strung together, a ratio of roughly four biconical beads to each grooved barrel is produced. Combined, they would form a strand 62 centimeters in length, quite close to the 60 cm length of a grain-of-wheat bead necklace found at Asine (Frödin and Persson 1938, 399).

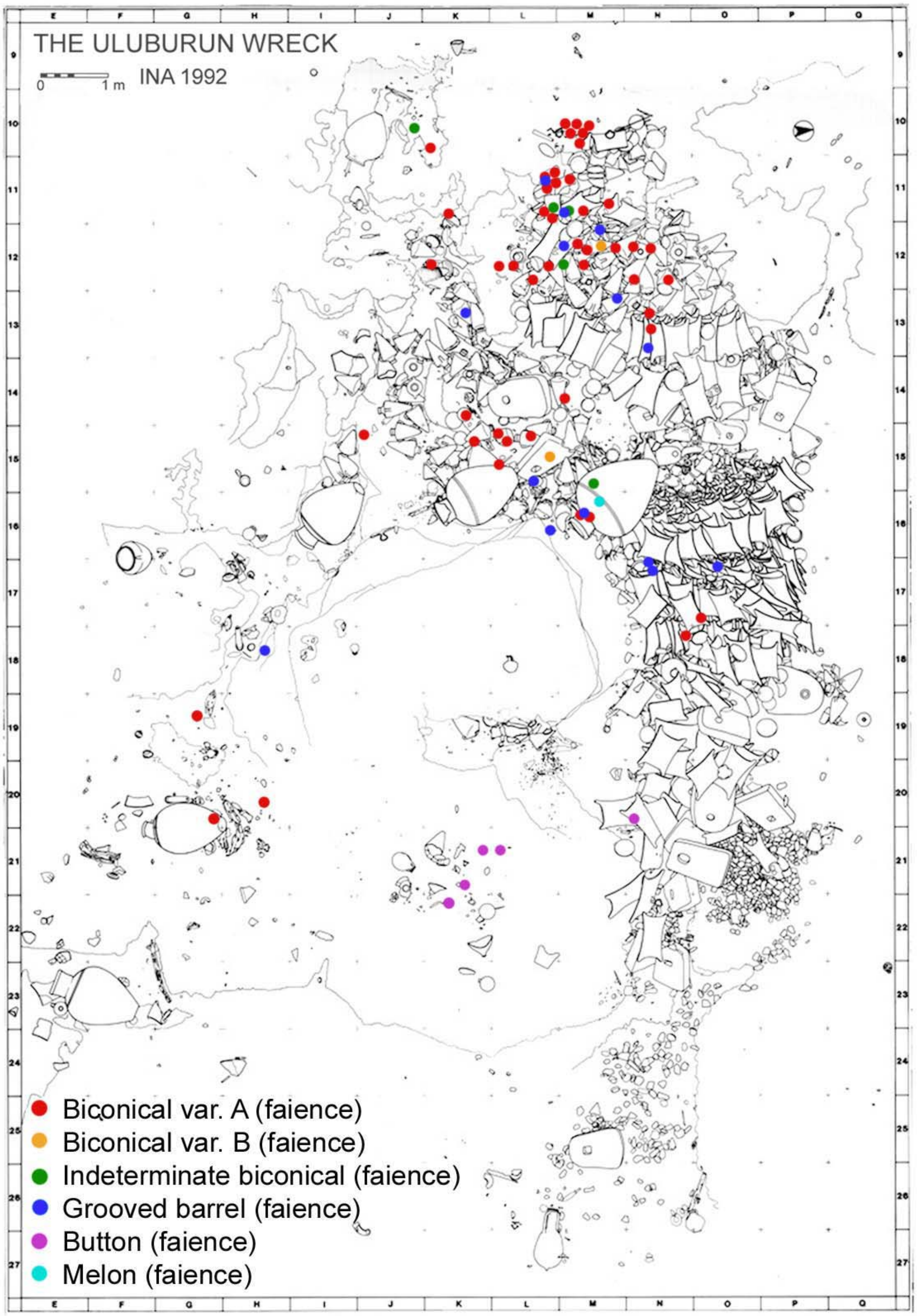

Fig. 3.6. Distribution of biconical, grooved barrel, button and melon faience beads on the site plan. (After Pulak 1998, 192, fig. 4)

Only five faience button beads were identified among artifacts recovered from the wreck; these were plotted and found to have a unique pattern of distribution, as shown in figure 3.6. They lie to the southeast of the wreck in a rough three-meter line approximately perpendicular to the ship's keel. Their dissociation with the distribution of any glass or faience bead category further adds to the obscurity of this small group.

Glass Beads

Three different groups of glass beads were mapped on the wreck site: small glass beads, large glass beads that could not positively be identified as eye beads, and large glass eye beads (both simple spot and crumb eye beads).

Although isolated small glass beads were found scattered throughout the site, these beads were primarily concentrated in two areas at the western end of the wreck (fig. 3.7). One such dense aggregation, in Canaanite jar KW 8, was found in square K12; the other concentration lay just two meters north in square M12. Canaanite jar KW 8 (fig. 2.17) was filled with small glass beads; as in the concreted mass of tiny faience beads, KW 76, only one size appears to be represented. The small glass beads in Canaanite jar KW 8 constitute a concreted mass estimated to contain at least 7,500 beads.[9] None of the other categories of glass beads were found near Canaanite jar KW 8. Conversely, the group of small glass beads in square M12 is a mixture of small and large glass beads at a ratio of about one large bead to every 40 small beads. Although these two concentrations of small beads

[9] This number represents a conservative estimate. Calculations to determine the number of beads present in this concreted mass are provided in app. C.

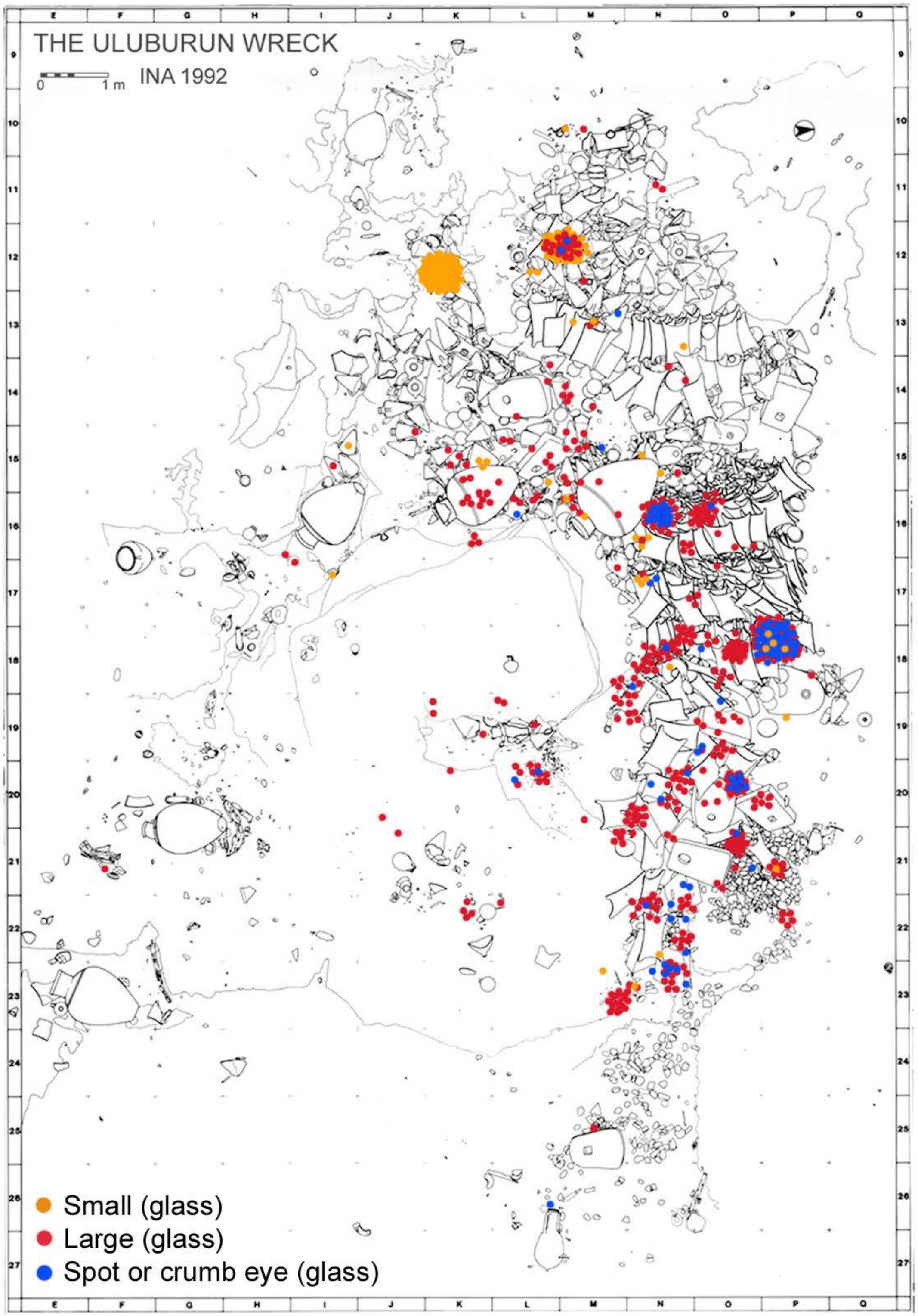

Fig. 3.7. Distribution of glass beads on the site plan. (After Pulak 1998, 192, fig. 4)

are in close proximity, they differ in composition and may therefore represent the contents of two separate receptacles.

The large glass beads possess a wide distribution covering the wreck site from the stern to the bow of the ship. Besides the grouping with small glass beads in square M12, the large glass beads on the western half of the wreck were sparsely scattered. In contrast, those on the eastern half of the wreck formed concentrated pockets (O-P18, O20, O21 and M23) with apparent southeasterly drift.

Only a relatively small percentage of the large glass beads are positively identifiable as eye beads; once plotted, though, they form a pattern of distribution nearly identical to that of large glass beads. This concurrence of distribution patterns implies that the groups were intermixed or transported together and provides support for the theory that all large glass beads found at Uluburun are, in fact, flush spot or crumb eye beads, although most may no longer be recognized as such due to poor preservation.

Discussion

Certain bead categories have been interpreted as elements of cargo because the style thereof is wide-spread throughout the Levant, they are represented by a large number of beads, and they exhibit manufacturing flaws that preclude their use (that is, some beads of the category exhibit incomplete or blocked perforations). Categories that fulfill all three criteria include tiny and globular faience beads and large and small glass beads. Each of these categories forms a centralized distribution pattern, in which one or more "hot-spots" are formed by a concentration of beads with varying degrees of drift downslope or to the southeast. This pattern is consistent with what one would expect of bulk goods transported in containers, whether bags or jars: after initial impact, the breakdown of the container and subsequent artifact shifts would cause dispersal from one or more concentrated locations. Drift to the east or southeast is consistent with the nature of the site and the orientation of the ship and is demonstrated in the distribution of larger elements of cargo.[10]

Although the cogwheel faience beads fulfill the first two criteria for cargo, they do not exhibit manufacturing flaws that would preclude stringing. Nevertheless, their distribution matches that outlined for cargo beads, suggesting that the cogwheel faience beads also represent an element of cargo.

Categories of beads which may be labeled as personal belongings of a passenger or member of the ship's crew, conversely, more likely embody a regional rather than general style, are relatively few in number, and lack manufacturing flaws that preclude stringing. Categories fulfilling these criteria are the faience grain-of-wheat and button beads. The distribution patterns of these two categories differ, but are nevertheless dissimilar to the general cargo distribution pattern.

The remaining categories fail to meet all three criteria outlined for either cargo or personal items. However, both the faience bicones and the grooved barrels are few in number and free of significant manufacturing flaws; furthermore, these beads form a very loose distribution lacking any concentration and may, in fact, have been transported together. Both categories, therefore, likely represent personal items rather than cargo.

[10] Lin (2003) provides an analysis of the distribution of anchors, ingots, and ceramics.

Conversely, the collared cogwheel beads, although also few in number and lacking in manufacturing flaws, form a distribution pattern that matches that of plain cogwheel beads and may, therefore, be an item of cargo.

The solitary melon bead (KW 5174) is the only bead whose role on the ship remains indeterminable. Although only one such bead was found, its style is well-known throughout the Levant. Furthermore, due to its location it could theoretically be linked to any category of faience bead found at Uluburun. There is also a possibility that this bead was lost on the ship during a previous voyage.

Location and Mode of Containment for Cargo Beads

The small glass beads may be securely placed in the stern, a minor contribution to the cargo necessary to counterbalance the significant weight in the bow.[11] KW 8 provides direct evidence that many of the small glass beads were transported in a small-sized Canaanite jar. The other concentration of small glass beads (in M12) lay two meters north, within close proximity of the largest concentration of small-sized Canaanite jars;[12] as such, this group may also have been originally stored in a jar.[13] The distribution pattern for large glass beads (including eye beads) does not correlate with the distribution of Canaanite jars, with the exception of the concentration coinciding with small glass beads in M12. It is possible, then, that one Canaanite jar contained only small glass beads, while another Canaanite jar contained a mixed variety of glass beads.

[11] Lin 2003, 107.
[12] Evidence suggests that all of the Canaanite jars were originally stowed in the stern (Lin 2003, 188, fig. 6.2, 190).
[13] The small glass bead concentration in M12 included some large glass beads, while Canaanite jar KW 8 only held small glass beads, suggesting the M12 group originated in a separate container.

The Late Bronze Age shipwreck near Cape Gelidonya also carried mixed glass beads, including striped barrels, spheroids and disk beads, in one ceramic container, providing support for this theory.[14] There is, however, no direct evidence for the mixing of beads on the Uluburun shipwreck, and that the two bead concretions found at Uluburun contain beads of only one kind provides evidence to the contrary.

The faience bead cargo (tiny, globular and cogwheel beads) was centralized in one general area near the center of the ship, to either side of pithos KW 251. Considering downslope shifts, these beads were probably stored somewhere aft of this location, although precisely where is unclear. While faience beads designated as cargo coincided with the scattered Canaanite jars near pithos KW 251, there is no direct evidence suggesting these beads were carried in the jars. Furthermore, as previously mentioned, the shape of tiny bead concretion KW 76 suggests storage in a bag rather than a jar.

Another theory on containment, as suggested by Wachsmann, is that the beads were sewn onto cloth or garments serving as luxury trade items.[15] This is most plausible for the tiny faience beads, for which archaeological parallels of contemporary date exist.[16] This style of bead was long used in embroidery in Egypt, and a scrap of linen with small groups of tiny carnelian beads was found in a Predynastic grave at Tarkhan.[17] As previously noted, such beads were also used to embroider a linen skull cap in which the 18th-Dynasty king Tutankhamen was buried, and many of the garments found in his

[14] Bass 1967, 132-3.
[15] Wachsmann 1998, 306.
[16] For a discussion of beaded textiles, see Barber 1991, 154-5, 171-3.
[17] Petrie et al. 1913, 22, no. 5.

tomb were decorated with beads.[18] Barber interprets the tiny gold beads found scattered near a loom at Troy II as evidence that tiny beads were woven directly into textiles.[19] The colorful zigzag pattern exhibited by a concretion of 40,000 tiny faience beads at Dendra is further evidence of beadwork; the Dendra beads are 0.15-0.3 cm in diameter and, like the tiny beads of Uluburun, include some segmented beads.[20] Persson likens the find at Dendra to Egyptian beading, which implies that this item was a luxury import, one which would fit well within the context of the Uluburun shipwreck.

Contrary to this hypothesis, the compact nature of the concretion and lack of bead alignment suggest that the tiny faience beads in concretion KW 76 were not sewn onto fabric. However, as noted in chapter II, the beads in KW 76 exhibit far less variation in size than do other tiny faience beads and almost certainly represent a discrete shipment. The remaining tiny beads were found throughout the wreck site. If such beads were sewn onto or woven into textiles, or simply strung together to form a bead net, the organic fibers holding them together would certainly have disintegrated in the marine environment, producing the wide scatter of tiny faience beads noted above. These beads may, then, have been incorporated into textiles in such a way; however, because direct evidence of this phenomenon is lacking, the theory cannot be proved.

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[18] Carter and Mace 1923, 1:159, 167-9, pl. XXXIV; 2:113.
[19] Barber 1991, 172; cf. Blegen et al. 1950, 350-1.
[20] Persson 1931, 79-80, 106, no. 51.

CHAPTER IV

FAIENCE: MATERIAL AND MANUFACTURE

The Origins of Faience

The development of faience occurred considerably earlier than that of glass, and some scholars consider faience an early stage in glass development. While detailed ancient texts describing glassmaking aid scholars in understanding the early glass industry, no such texts exist for the faience industry. As a result, much of the scholarly work on the subject is based on a combination of experimentation and observation.[1]

The term faience has been described as "…a long-standing misnomer for a composite material consisting of a sintered quartz body and a glaze."[2] Upon firing, the silica or quartz particles in faience sinter or fuse together, and the glaze or efflorescent salts on the surface melt, forming a hard albeit porous body with a bright, shiny glaze.[3] This differs from glass, which melts completely. Europeans applied the term faience to the colorful, glass-like artifacts they saw in Egypt, which resembled the late-Medieval tin-glazed pottery for which Faenze, Italy, was known.[4] Other terms commonly applied to faience include sintered quartz, glazed frit, Egyptian faience, and paste. This variety of terms is understandable considering the fact that many ancient faience pieces retain little or no trace of their original glaze and are therefore mistaken for another material.[5]

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[1] Moorey 1994, 182.
[2] Moorey 1994, 167.
[3] Vandiver 1983a, A26-7.
[4] Nicholson 1993, 9.
[5] Moorey 1994, 167.

In some cases, the term faience has been incorrectly applied to other glazed materials; for example, upon further analysis, a number of Predynastic Egyptian “faience beads” in the Ashmolean Museum, Oxford, were found to be glazed steatite rather than faience.[6] Blue faience can also be confused with Egyptian Blue, a type of blue frit, the positive identification of which is possible only through X-ray diffraction analysis.[7]

Glazed stones predate faience finds and represent the final step towards its development; commonly used stones include magnesium silicates, such as steatite or serpentine, and silicates, such as quartz or flint.[8] These stones were sculpted, coated with a glaze then fired, resulting in a shiny and, with steatite, harder stone.[9] Beads made in this fashion have been found at Mohenjodaro, in the Indus Valley; an unfinished steatite bead at this site shows that, to prevent breaking a sculpted bead, the perforation was drilled prior to sculpting.[10]

The use of glazed stone continued after the introduction of faience, and glazed stone beads are often found alongside their faience counterparts. Although early examples of Egyptian faience, in the form of beads, date to the Amratian period (4000-3500 B.C.), the origins of faience appear to lie in western Asia, where faience beads date to the Ubaid period (5400-4300 B.C.).[11]

A close association between faience and beads is apparent throughout the eastern Mediterranean, perhaps because beads were the first articles made of faience. The

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[6] Vandiver 1983a, A64
[7] Moorey 1994, 186.
[8] Moorey 1994, 168.
[9] Foster 1979, 3; Moorey 1994, 169.
[10] Marshall 1973, 526.
[11] Moorey 1994, 168-9.

Egyptians used the term *thnt*, meaning dazzling or shining, to denote faience, and the determinative following this term represents a beaded pendant. [12] Many Mediterranean Bronze Age cultures used faience to imitate beads of precious stones. Linear B tablets from Pylos and Mycenae make reference to *ku-wa-no*, glass paste or faience, which bears similarity to the Hittite term for dark blue beads, *ku(wa)nnan*.[13]

Faience Composition and Manufacture

The majority of studies on ancient faience concern the Egyptian faience industry; for that reason, the production methods outlined here will focus on work from that region. Bronze Age faience consisted of three primary ingredients, which varied in proportion. Silica was the primary ingredient, comprising 92-99% of Egyptian faience; it was commonly obtained in the form of ground quartz or sand.[14] Lime, comprising 1-5% of Egyptian faience, initially occurred as an impurity in the silica. Soda or sodium carbonate comprised 0-5% of Egyptian faience and was commonly obtained through natron or plant ash.

The addition of pulverized minerals resulted in different colors of faience; some minerals, depending on their state of oxidation, can produce a range of colors.[15] Bronze Age faience artisans commonly used copper for producing green, light blue, and red, cobalt for dark blue, and tin for yellow. Because silicas can contain any combination of different minerals, early experimentation with color was achieved through use of a

[12] Foster 1979, 12. Nicholson (1993, 11) also notes that, although the term *thnt* was used for glass in some cases, it more often referred to faience.
[13] Foster 1979, 10-1.
[14] Vandiver 1983a, A18.
[15] Moorey 1994, 184.

variety of siliceous materials. Manganese oxide, use of which first appeared during the New Kingdom (18th Dynasty), produced purple and may also have functioned as a decolorizer in the faience paste.[16]

The pulverized combination of silica, lime, soda, and additional minerals for color was then mixed with water. The resultant paste was thixotropic, meaning that the paste, when manipulated, becomes more fluid.[17] This paste was formed into the faience body through a variety of means. In Egypt, early faience was modeled by hand and, if necessary, sculpted further with tools once it was leather-hard.[18] There are suggestions that faience was thrown on a wheel in Egypt and the Aegean, although this was probably rare due to the thixotropic nature of faience paste.[19] During the Middle Kingdom in Egypt, new techniques of molding and core-forming were developed.[20] To mold a faience body, a lump of paste was pressed into an open-faced, or female, mold, or formed around a convex, or male, mold.[21] In core-forming, dung or plant matter mixed with clay was shaped into the desired form; faience paste was then applied onto this core.[22] Upon completion of the glazing process, the core was chipped out and discarded.

The technique of manufacturing beads around a combustible core was employed in Egypt and the Aegean; with this technique, the faience paste was shaped into a bead around a stick or reed which, upon firing, disintegrated, resulting in a bead with a

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[16] Nicholson 1993, 43.
[17] This attribute makes faience paste more difficult to work with than clay (Kiefer and Allibert 1971, 110).
[18] Vandiver 1983a, A17.
[19] Foster 1979, 2.
[20] The method of core-forming was similar to that used in the production of glass vessels.
[21] Vandiver 1983a, A23.
[22] Nicholson 1993, 52-3.

perforation for stringing.[23] Recent experiments with this technique using stalks of grain as the combustible core have confirmed its effectiveness.[24]

Once dry, the faience body was glazed through one (or a combination) of the following three methods.

1. *Efflorescence* is the first of two self-glazing techniques.[25] During the drying process, the alkaline salts present in the faience body—sodium carbonates, sulfates, and chlorides—migrate to the surface. At the surface, these salts effloresce, or become converted to a powdery white layer as the water evaporates; this process usually occurs within 30 minutes. Upon firing, the powdery outer layer melts and fuses with the silica and lime at the surface of the faience body, thereby forming a glaze. Unless the object was turned during the drying process, efflorescence will not have occurred on the side on which the object was resting, resulting in a lack of glaze in that area.[26]

2. *Cementation* is the second self-glazing technique, in which the dried faience body is deposited in a dish containing a glazing powder. This powder consists of soda, lime, and copper, the proportions of which are variable.[27] The entire dish containing the glazing powder and multiple faience bodies is placed into the kiln. Upon firing, the glazing powder melts partially at the surface of the faience body, resulting in an even layer of

[23] Kiefer and Allibert 1971, 110.
[24] Kiefer and Allibert 1971, 116.
[25] Vandiver 1983a, A31-3.
[26] This phenomenon was witnessed in Kiefer and Allibert's (1971, 114) experiments with the process.
[27] Vandiver 1983a, A33-8. Experiments with faience have shown that any number of combinations of these three elements will produce a suitable glaze.

glaze; the unmelted glazing powder crumbles away after firing. This technique is still practiced today and has been recorded in the small bead factories in Qom, Iran.[28]

3. *Application* is not considered self-glazing because the glaze is applied manually.[29] This process uses a glazing slurry consisting of powdered quartz, calcite, and natron, mixed with water. After the development of the glass industry around the 16th century B.C., ground frit was added to the mix to enhance glassiness. This slurry is applied to the dried faience body by dipping, pouring or painting; the porous body absorbs the water in the slurry, leaving a powdery layer on the surface. As with efflorescence, this powdery outer layer melts entirely upon firing and forms a glaze. Drips and flow lines resulting from the application of the glazing slurry are sometimes visible on the finished piece.

Experiments in re-firing scraps of ancient Egyptian faience suggest that pharaonic faience was fired between 870-920° C.[30] During the firing process, the silica grains in the body become sintered and a reaction between the alkali and silica forms a glaze on its surface. This process is not completely understood, though, and it is unknown what role is played by the lime present in both the faience body and the glaze material, whether slurry or powder.[31]

A cross-section of faience, when viewed under low magnification, exhibits a layered structure, as do glazed stone and clay-based ceramics.[32] While sometimes only

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[28] Wulff et al. 1968.
[29] Vandiver 1983a, A27-9.
[30] Kiefer and Allibert 1971, 112. Nicholson allows for a wider range, between 800-1000° C (Friedman 1998, 55).
[31] Vandiver 1983a, A34.
[32] Vandiver 1983a, A13.

the body and glaze layers are visible, there exists at times an intermediate layer, which Vandiver labels the glaze-body interaction zone; this is a result of unintentional chemical reactions between the glaze and body. This layer can be common with application glazing. It tends to occur more frequently when the faience is fired at higher temperatures, above 950° C, or when the amount of soda or lime used exceeds 10%.[33] In Egyptian faience of the Middle and New Kingdoms, the manufacturer might have purposely added a layer of finely-ground quartz between the faience body and glaze; this served to enhance the color of the glaze and increase the fusion between the body surface and glaze.[34]

A wide array of objects can be produced using the above techniques. While the earliest faience finds consist of simple beads, faience objects created during the Late Bronze Age were far more elaborate. In Egypt, such objects include sculpted statuettes, urns, tiles and *shabtis*, in addition to more intricate beads.[35] New Kingdom faience does not reflect technological innovation; techniques used were originally developed during the Old and Middle Kingdoms. However, there was an increase in the diversity of forms created during the New Kingdom, with a noticeable emphasis on personal adornment; Egyptian faience manufacturers also began to imitate foreign ceramics such as Mycenaean stirrup jars. Additionally, an increase in the quantity of faience objects and the tools used in the manufacture thereof, especially molds, suggests increased organization of the industry.

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[33] According to Vandiver (1983a, A28), "Higher firing temperatures and flux concentrations cause the glaze to soak into the body, obscuring the boundary, and lead to formation of an interaction zone between glaze and body, and to a thin layer of glaze."
[34] Vandiver 1983a, A14-5.
[35] Friedman (1998) provides numerous examples of Egyptian faience.

Although elaborate faience beads, vessels and plaques have been found in the Aegean, the faience industry in that region experienced a decline, both quantitative and qualitative, near the middle of the second millennium B.C.[36] Conversely, an expansion of faience production is seen in the middle of the second millennium B.C. in Mesopotamia. This expansion, termed the Mittanian phase of faience production, occurred between 1550-1350 B.C. and is reflected in the large number of prestige goods found during the period.[37] During this phase, faience, being a prestige item, was found primarily in association with temples and palaces. During the Middle Assyrian phase (1350-1200 B.C.), production became more broadly based; this is apparent in the "wide circulation of a standard repertory" of objects.[38] Faience distribution during this phase was more widespread, and the material began appearing frequently in graves.

Evidence of Faience Manufacture in the Archaeological Record

Although iconographic evidence of faience manufacture is rare, one depiction exists in the 26th-Dynasty tomb of Aba at Thebes. According to Davies, a wall painting in this tomb depicts one man preparing the faience paste in a dish while a second man fashions a lily-shaped ornament, presumably also of faience (fig. 4.1).[39] While there are

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[36] Foster 1979, 157; Evely 2000, 458.
[37] The name for this phase is derived from the kingdom of the Mittani, which "…stimulated and facilitated the production and diffusion of such luxury objects." (Moorey 1994, 178)
[38] Moorey 1994, 178.
[39] Davies 1902, 37.

depictions of bead drilling in other Theban tombs, such depictions probably represent the manufacture of stone rather than faience beads.[40]

Fig. 4.1. Faience workers depicted in the 26th-Dynasty tomb of Aba at Thebes. (After Davies 1902, pl. XXV)

There exist two literary references to faience manufacturers in Egypt; an Old Kingdom mastaba notes an official who was *shm hwt thnt*, or "controller of the *thnt* workshop", and a Middle Kingdom (13th or 14th Dynasty) stela mentions the *ímy-r thnt*, or "overseer of *thnt*."[41] In the Aegean, the term *ku-wa-no-wo-ko-i*, glass paste or faience workers, appears in the Linear B tablets at the Citadel House at Mycenae, confirming a local manufacture of faience in association with the palace.[42]

Archaeologists excavated a faience bead factory in Late Bronze Age strata at Tyre, in modern-day Lebanon. A stone "work table", found at stratum XVI, was

[40] Both bead drilling and stringing are depicted in the tombs of Amenhotpĕ (Davies 1923, 10-2, pl. X) and Nebamun and Apuki (Davies 1925, 57, 63, pl. XI).
[41] Foster 1979, 13.
[42] Foster 1979, 10.

reconstructed as a three-sided grinding basin. This basin was covered in "white chalky paste", which Brill later identified as a pure form of calcium carbonate, a component of faience.[43] In the subsequent stratum XV, a pithos sunk into the floor served as a kiln; an opening cut into the pithos led to an adjoining pit, likely the firing chamber of the kiln.[44] Moreover, a "small pile of very smooth sea pebbles" located near the pit might have served as the silica source for the faience; otherwise, the clean sand nearby would have sufficed.[45] Large amounts of faience beads were found at these strata, and almost 1,900 red faience beads were found at subsequent stratum XIV, suggesting the continuation of faience manufacture in this location.

Remains of a 12th-Dynasty faience bead factory at Lisht, Egypt, provide evidence for the use of combustible cores. At this site, faience beads were found on slender reeds, presumably awaiting firing.[46] The remains of both faience and glass factories were excavated at the 18th-Dynasty site of Amarna, Egypt. At the site, Petrie recovered thousands of baked clay molds, used in the manufacture of faience bodies.[47] These molds were used in the production of a wide variety of rings, pendants, and inlays.

Manufacture of the Faience Beads Found on the Uluburun Shipwreck

For faience bodies retaining a surface glaze, glazing method may often be identified through visual analysis of drips or glaze variation, or microscopic analysis of

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[43] Bikai 1978, 7, 92.
[44] A layer of plant ash found in the pit and pieces of charcoal in the pithos reaffirm this reconstruction (Bikai 1978, 7-8, 92).
[45] Bikai 1978, 8.
[46] Friedman 1998, 58; Nicholson 1993, 30.
[47] Petrie 1974, 28.

the glaze and interaction layers. However, because none of the faience beads found on the Uluburun shipwreck retains an intact surface glaze, visual analysis proves to be of little value in identifying the glazing method. Furthermore, microscopic analysis revealed that the beads retain only a partial interaction layer, if any, and no glaze layer at all. As a result, the glazing method may not be definitively established for these beads.

Nevertheless, some of the faience beads, especially those representing cargo, exhibit characteristics or flaws that may aid in understanding aspects of their formation and firing. All faience beads found on the Uluburun shipwreck are characterized by a round perforation that is approximately straight. This suggests that the beads were formed on a straight wire or reed rather than pierced after forming, which would more likely create a conical perforation. Modern experiments reveal that faience beads fired while still on a metal wire result in difficulty in removing the bead from the wire and in deposited residue inside the perforation.[48] Therefore, it is more likely that these beads were either formed on a metal wire and removed prior to firing, or formed and fired on a combustible reed as noted above.

<u>Tiny Beads</u>

Manufacturing flaws evident on tiny beads include tapering ends (for segmented beads only) and conjoined bead clusters. The tiny segmented bead shown in figure 4.2 exhibits distinct tapering at one end. Similar tapering may be seen in Lot 11437i, where the perforation is misshapen at the tapered end (see figure in app. B).

[48] Beck and Stone 1936, 210-1.

Fig. 4.2. Tiny segmented bead from Lot 10314 exhibiting tapering.

The presence of a tapered end suggests that the faience was rolled to produce a long cylinder, then rolled across a ribbed surface to achieve a segmented strip which could be sliced to form beads. The beads from the ends of such a rolled strip of faience would be thinner and weaker than those in the middle, resulting in the taper and warped ends seen on some of the Uluburun segmented beads. Beck and Stone, in their analysis of the segmented beads found in Britain, suggest a similar theory:

> The method of manufacture of the normal segmented beads has also been partly elucidated, and successful beads … have been made by means of a wooden tool like a butter-pat. For this purpose the powdered materials must be rendered plastic by a suitable admixture of water. The careful use of such a tool enables the material to be moulded into either segmented or spiral beads and other forms. The Wiltshire beads possess differently shaped grooves between the segments, and these can all be reproduced by this method.[49]

If this is how the segmented beads from the Uluburun shipwreck were made, a regular tiny bead could be created in the same fashion, by merely cutting the grooved strip one segment at a time; Petrie suggests the use of such a method in tiny and

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[49] Beck and Stone 1936, 210.

segmented faience beads found at Gurob.[50] The tiny and segmented beads exhibit similar color and dimensions, and both types have been found together at other archaeological sites, including Dendra[51] and Prosymna[52] in Greece. If manufactured in this way, the tiny and segmented beads would likely be fired together. Support for this may be seen in figure 4.3, which shows a cluster of blue beads from Lot 10314. This cluster includes a small, misshapen segmented bead adhering to a non-segmented tiny bead of the same color; the intermediate area, when viewed under low magnification, is a vivid, glassy blue.[53]

Fig. 4.3. Tiny and segmented bead cluster from Lot 10314 with blue glaze between beads.

Regular tiny beads are often found adhering to other tiny beads, although always of the same color. Some such beads form stacks or cascades (Lot 10623.e-g and Lot

[50] Petrie 1890, 37.
[51] Persson 1931, 106.
[52] Blegen and Blegen 1937, 1:310-1.
[53] Lot 10623.h-i in fig. B.4 is similar to this example.

9271.a-c, figures in app. B). In some cases, as in the group in figure 4.3, the remains of surface glaze may be barely visible between the conjoined beads, suggesting the beads became attached during glazing. This provides further evidence that the beads were either fired loose or on a combustible reed rather than on a metal wire, as the latter would prevent such formations.

Globular Beads

As seen in the tiny beads, globular beads exhibit irregularities incurred during both formation and firing. Formation flaws include stretching and bunching of the faience as well as general deformation of the spheroid shape. Stretched beads (KW 3144, fig. 4.4) are characterized by an excess of faience material at one end, drawn out and pulled to one side, terminating in a ragged edge. Although beads exhibiting severe stretching are rare, many beads, such as KW 4129 (figure in app. B), show a slight pull at one end, forming a small peak near the perforation. A slight bunching of the faience material at one end, such as that of KW 4131 (fig. 4.4), occurs primarily in conjunction with a flattened end and forms a bunched ring, partial or complete, around the perforation, similar to a collar. This bunching may have resulted from an attempted repair of a stretched bead end.

The stretched and bunched ends would not likely be formed while the bead was on a wire or reed. However, because the process of firing hardens the bead, distortion of the bead shape must have occurred either before or during the firing process. The extent of distortion exhibited by some beads would not have resulted during firing, thereby suggesting that these beads were not fired on a combustible reed, but were loose when fired.

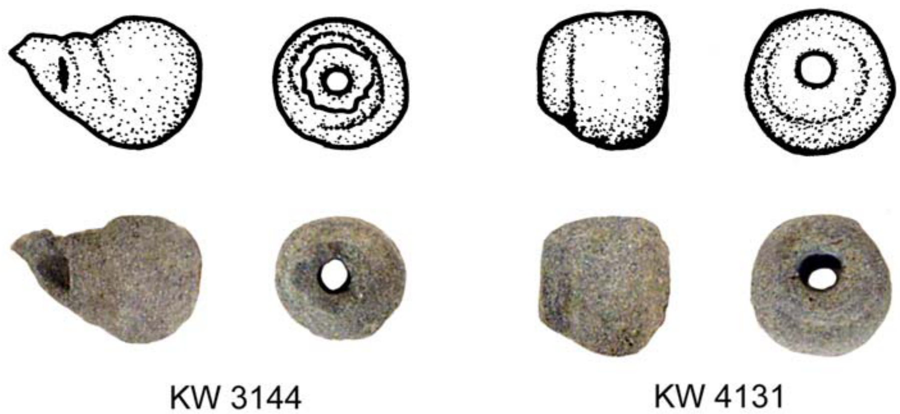


Fig. 4.4. Globular faience beads exhibiting stretching (KW 3144) and bunching (KW 4131). Scale 3:1.

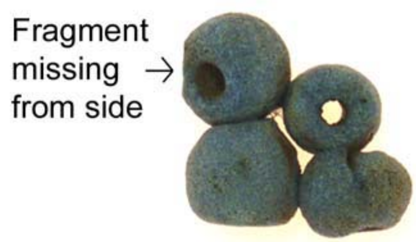


Fig. 4.5. Globular faience bead cluster KW 5307. Scale 3:1.

Irregularities resulting from firing include conjoined bead clusters; the four beads in figure 4.5 (KW 5307) show slight irregularities in form to accommodate one another. In addition, many globular beads have a fragment of another faience bead adhering to one side or a large pit from which such a fragment might have broken (figs. 4.5 and 4.6). This is likely caused by the breaking apart of beads which became joined during the firing process, as might result from cementation glazing. Figure 4.7 shows a cross-section of a globular bead with an adhering fragment viewed with a scanning electron microscope; the surfaces of both the bead and the fragment have fused together, confirming that it became attached during the firing process.

These irregularities would be expected in the "Qom process" of cementation glazing; this process, documented in a small, modern-day faience bead factory in Iran, entails a mass production of beads, up to 40,000 at a time.[54] Once the beads are fired, the entire contents of the glazing dish is thrown on the floor and broken apart by workers stepping on it. Cementation glazing and the subsequent rough extraction process would account for both the clustering and fragmentation of globular beads.

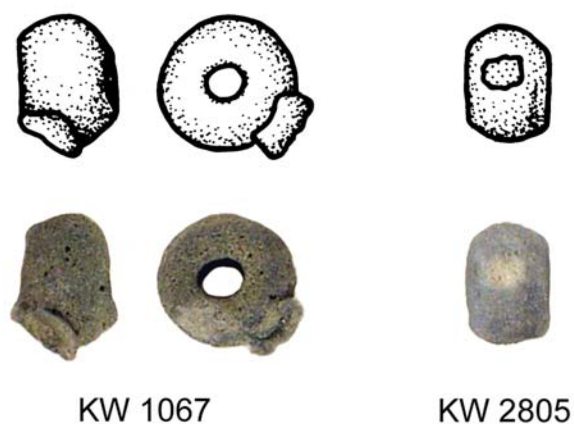


Fig. 4.6. Globular faience beads with adhering fragment (KW 1067) and missing fragment (KW 2805). Scale 3:1.

[54] Wulff et al. 1968, 101.

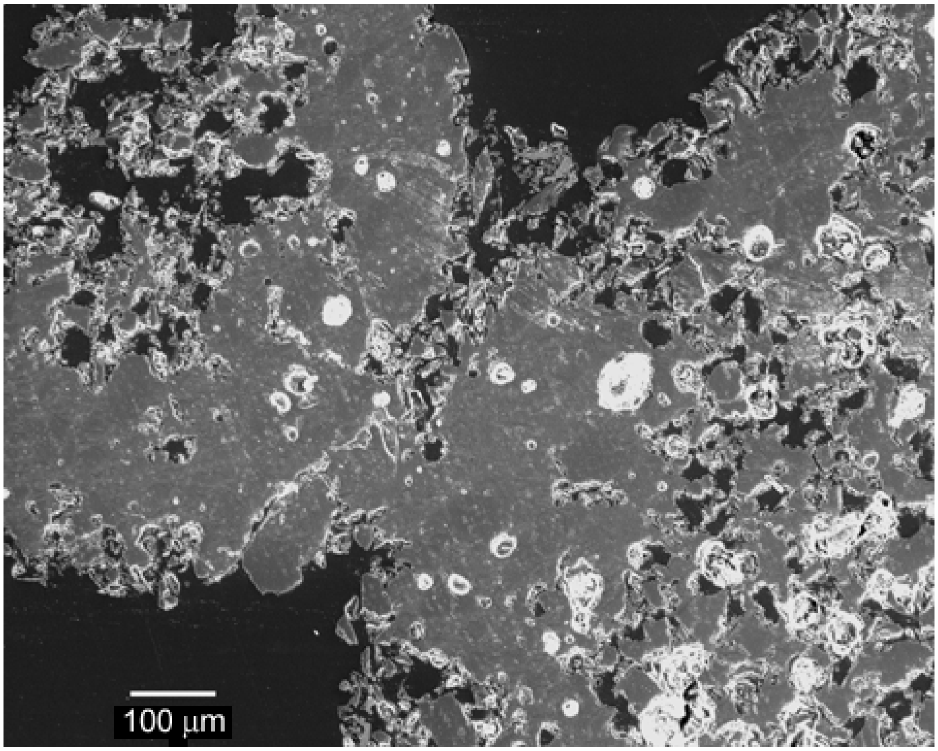
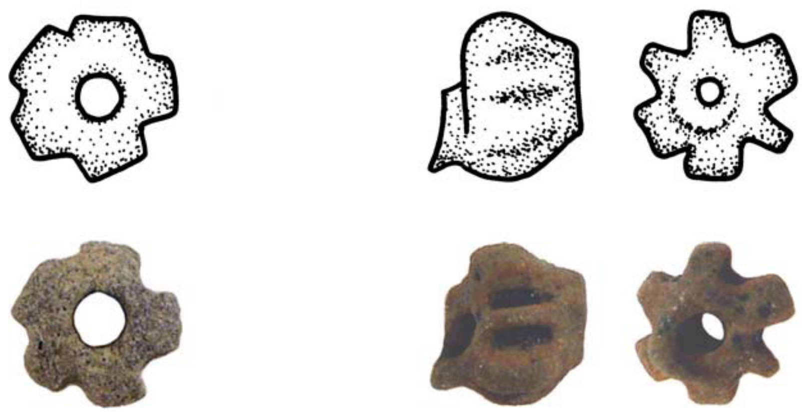


Fig. 4.7: SEM image of a globular bead from Lot 11299 with adhering fragment (magnification 100x).

Due to the crude design and the assumed large scale of production of the globular beads, it is unlikely that the application process of glazing was employed in their manufacture. Rather, the cementation method more accurately reflects the flaws noted above, and would entail firing the beads loose rather than on a reed or wire, as suggested by irregularities in bead form.

Cogwheel Beads

The cogwheel beads exhibit flaws related to forming. As noted in chapter II, the number and nature of flutes vary significantly. The depth of fluting varies, sometimes within the same bead as exemplified by KW 4782 (fig. 4.8). Bead KW 5000 (figure in app. B) is seemingly unfinished, exhibiting three flutes along one half of the perimeter and no sign of fluting on the opposite half.



KW 4782 KW 2153

Fig. 4.8. Cogwheel faience beads exhibiting inconsistent flute depth (KW 4782) and an irregular end (KW 2153). Scale 3:1.

Irregular bead ends, as seen on KW 2153 (fig. 4.8), may indicate that the cogwheel beads were created in long strips, then broken apart to form individual beads, similar to the proposed technique for tiny and segmented faience beads. This is further supported by the presence of segmented gear beads with two segments each (KW 5201 and KW 5671, figures in app. B). The fluting on each segment of such segmented beads is identical in depth and spacing, confirming that such beads were created in multiples and broken apart, perhaps through use of a tool similar to that used in creation of the tiny faience beads. Uneven pressure while rolling a strip of faience across such a tool would also account for irregularity in flute depth.

Grain-of-Wheat Beads

The grain-of-wheat faience beads, like the cogwheel faience beads, exhibit irregularities incurred during formation. Some beads, like KW 5479 (fig. 4.9) exhibit a lopsided perimeter; similar beads found at Elateia-Alonaki also exhibit a lopsided perimeter, which Nightingale attributes to excessive pressing during manufacture.[55] Cracks inside the longitudinal grooves are not infrequent (KW 3632, figure in app. B); some beads also possess smaller, transverse cracks along their edge (KW 4309 and KW 4327, figures in app. B). This, along with an irregular transverse section, may also suggest uneven or excessive pressing during manufacture.

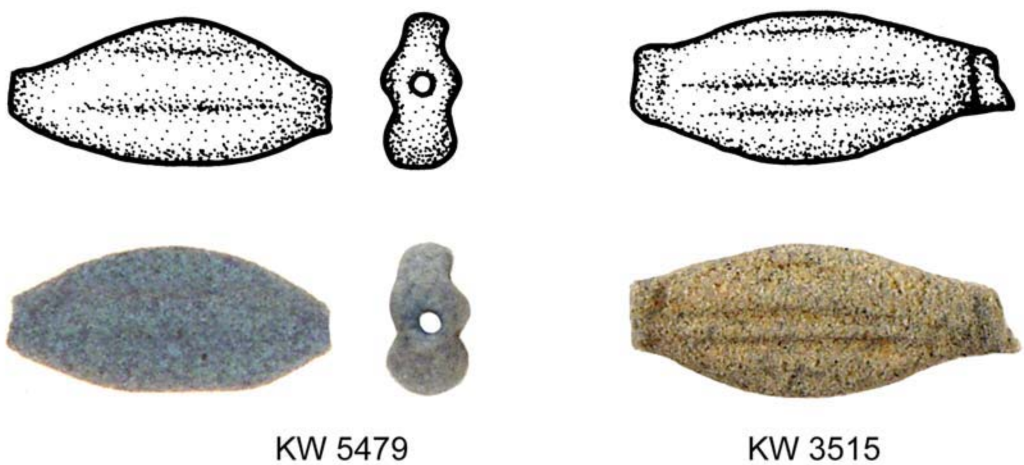


Fig. 4.9. Grain-of-wheat faience beads exhibiting a lopsided perimeter (KW 5479) and ragged end (KW 3515). Scale 3:1.

Some of the grain-of-wheat beads exhibit irregularly long or ragged ends. This is exemplified in KW 3515 (fig. 4.9); in this bead, a faint line is visible near the stretched

[55] Nightingale 1996, 146.

end, possibly representing a location in which the bead was to be scored. Contrarily, many grain-of-wheat beads, such as KW 3629 (figure in app. B), exhibit a blunt, broken end, while some beads (KW 4302, figure in app. B) possess one blunt, broken end and one elongated, ragged end. The presence of both stretching and blunting on the bead ends may indicate that these beads were formed in multiples, like the tiny and cogwheel beads, then broken apart to form individual beads.

Biconical Beads (Variant A)

A combination of features of the variant A biconical faience beads elucidates their unique manufacture technique. As stated in chapter II, each variant A biconical bead possesses radial decoration in transverse view, gadrooned on one face and incised on the opposite. The gadrooned or molded face, when preserved, exhibits 17 gadroons without exception; the number of gadroons is noteworthy, as rosette patterns with 17 segments are unusual during this period, 16 being far more common. Furthermore, analysis of preserved gadroons reveals a distinct pattern of relative gadroon width and orientation, and all preserved variant A beads exhibit this pattern. Both the unusual number of gadroons and their distinct pattern confirm that all variant A bicones with preserved surface were created in the same open-faced mold. As noted previously, similar molds, made of clay, were found in large number at Amarna, some possessing 17 segments.[56]

The incised face of the variant A bicones usually exhibits 17 incised lines, but may exhibit 16, as does KW 1690 (figure in app. B); these incised lines are somewhat

[56] Petrie 1974, 30, pl. XVIII.

imprecise and occasionally cross. Such inconsistency confirms that the incised face was not created by means of a mold, but was rather created by hand, accounting for the irregularities which starkly contrast with the consistency of the molded face.

In light of the above evidence, the manufacture of the variant A bicones may be reconstructed as follows: a lump of pliable faience paste was pressed into an open-faced rosette mold with 17 petals of slightly varying size. More faience paste than necessary to fill the mold was used, resulting in a lump of faience standing proud of the mold; this extraneous lump was then scraped or sanded down to a slightly convex surface, onto which were incised 17 lines to form segments matching the mold pattern. A small reed or metal pin could then be inserted into the center of the bead, which would both create the bead perforation and facilitate removal from the mold without damaging the delicate bead edge. This hypothetical method of manufacture accounts for both the consistency of the molded face and the inconsistency and short length of the incised face.

CHAPTER V

GLASS: MATERIAL AND MANUFACTURE

The production of a glass bead requires two steps: glassmaking, the process in which the glass is manufactured from raw materials, and glass working, the process in which the glass is formed into one of many bead shapes.[1] An active trade in glass ingots during the Bronze Age suggests that glass working could occur after a significant delay and in a different location from glassmaking.

Glass Composition and Origins

Glass, like faience, is a soda-lime-silica compound; Lucas lists its components as "…quartz sand, calcium carbonate, natron, or plant ashes, and a small amount of the colouring material."[2] Unlike faience, though, which is merely sintered, glass is fully melted to a liquid state and sets upon cooling.[3] Because the melting point of silica—1723° C—was too high for ancient glassmakers to achieve, soda was added as a catalyst to lower the melting point to a manageable temperature; this combination of silica and soda is known as "water glass".[4] Lime was added to this mixture to increase durability and stabilize the glass; it is, however, widely believed that lime was not deliberately included in early glasses, but naturally occurred as a mineral in the silica.[5]

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[1] Spaer 2001, 35.
[2] Lucas 1948, 219.
[3] Moorey 1994, 189.
[4] Francis 1982, 8.
[5] Moorey 1994, 206-7.

According to tradition, glassmaking originated near present day Akko, Israel. Here, the Belus River, also known as Na'aman, ran a short course to the sea, depositing a sand exceptional for glassmaking.[6] This sand was used in the accidental discovery of glass, which Pliny records in *The Natural History* as follows:

> The story is, that a ship, laden with nitre, being moored upon this spot, the merchants, while preparing their repast upon the sea-shore, finding no stones at hand for supporting their cauldrons, employed for the purpose some lumps of nitre which they had taken from the vessel. Upon its being subjected to the action of the fire, in combination with the sand of the sea-shore, they beheld transparent streams flowing forth of a liquid hitherto unknown: this, it is said, was the origin of glass.[7]

Although Pliny's story is often discarded as myth, it is important to note that the situation he described could quite feasibly produce a small quantity of glass.[8] Sand from the Belus River contained appropriate ratios of calcium carbonate, aluminum, and magnesium carbonate for the production of a high-quality glass.[9] Furthermore, *nitre* or natron, which served as an alkali in ancient glass, was frequently used in mummification and other rituals in Egypt and throughout the Levant. It is, therefore, more than likely that natron merchants, such as those described by Pliny, were traveling the Syro-Palestinian coast during that period.[10]

Today, most scholars concur with a west Asian origin for glass, which again agrees with the Belus River legend. During the 19th century A.D., however, some scholars attributed the development of glass to the Egyptians despite earlier finds from

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[6] Engle 1978, 9.
[7] Plinius 1857, 379.
[8] Lucas 1948, 212.
[9] Frank 1982, 72.
[10] Engle 1978, 13.

Assyria, Canaan, and Akkadia.[11] On the contrary, an early Mesopotamian cultural influence on Egypt can be seen in many areas, one being the Egyptian importation of lapis lazuli. This precious stone, mined in Afghanistan, was traded through Mesopotamia, and finds of lapis lazuli in northern Mesopotamia predate those in Egypt by roughly 500 years.[12] As with faience, the earliest glass artifacts, beads, were made in imitation of precious stones, most notably lapis lazuli. A remarkably well-made glass bead was found on a copper pin at Ga.Sur at Nuzi, dated to the 16th century B.C.; this piece was originally a hair ornament.[13] Earlier finds of nearly identical hair ornaments instead have a lapis lazuli bead as ornamentation, a clear confirmation of the link between lapis lazuli and glass beads.[14]

Glass artifacts dating to the 3rd millennium B.C. have been found in parts of Mesopotamia; such finds include chunks of glass found at Tell Brak and Eridu. However, Moorey describes the glassmaking industry at that time as "infrequent and irregular".[15] Moreover, the few Egyptian glass artifacts predating the 16th century B.C. are of questionable composition, and there is doubt as to whether their creation was intentional.[16]

The second half of the 16th century B.C. marked the commencement of the "Age of Glass", by which time the production of glass had become a true industry.[17] The period between the 15th and 13th centuries B.C. have been described as a time of

[11] Kurinsky 1991, 5-6.
[12] Mark 1997, 37-9.
[13] Starr 1939, 380.
[14] Moorey 1994, 190.
[15] Moorey 1994, 192.
[16] Lucas 1948, 209; Spaer 2001, 23.
[17] Spaer 2001, 23.

"experimentation and innovation", during which techniques were refined and new forms emerged.[18] The "Dark Age" of glass history soon followed, from 1200-850 B.C., and notable progress did not occur again until the 6th century B.C.[19]

Glass Manufacture and Trade: Textual and Archaeological Evidence

Due to the rarity of evidence for glass manufacture in the archaeological record, textual evidence, along with analyses of glass artifacts, is a primary source of information. Oppenheim's analysis of cuneiform glass texts is an invaluable asset to this field of study; these texts are taken from economic records, letters, and Sumerian and Akkadian word lists. One must bear in mind, however, that these texts were not meant as informative technical documents; rather, they primarily served administrative purposes and were "far removed from practical knowledge."[20] In addition, some scholars have suggested that ancient texts on glassmaking were purposely cryptic in order to preserve the jealously guarded secret of glassmaking.[21]

The link between early glass and precious stones is confirmed in these texts. The Akkadian term for lapis lazuli is *uqnû*; a distinction, however, is made between *uqnŭ kŭri*, "lapis lazuli from the kiln", and *uqnŭ šadĭ*, "lapis lazuli from the mountain".[22] A distinction between the two is seen in Assyrian texts as early as the second millennium

[18] Spaer 2001, 34.
[19] Spaer 2001, 27.
[20] Moorey 1994, 210.
[21] Kurinsky 1991, 31. Oppenheim (1988, 59) does not support such claims, which he describes as "facile and unfounded assertions."
[22] Oppenheim 1988, 10.

B.C., and also occurs with agate and obsidian.[23] A similar distinction is seen in the Amarna letters, where lapis lazuli, believed to represent glass, stands in contrast to "genuine" lapis lazuli, the precious stone. This distinction can be clearly seen in Amarna letter *EA25*, *Inventory of gifts from Tušratta*. Line i.38 of this letter records "{1 *mani*}*nnu*-necklace, of seal-shaped stones of lapis lazuli; 13 per string, mounted on gold." The next line, i.39, records "{1 *mani*}*nnu*-necklace, of seal-shaped stones; 13 seal-shaped stones of genuine lapis lazuli, mounted on gold…"[24]

The library of Assurbanipal at Nineveh is the primary source for texts on glassmaking; these texts, recorded during the 7th century B.C., are copies from an earlier period, probably the middle to late second millennium B.C.[25] According to Oppenheim, the intricate ritual activities which preface the texts betray the glassmakers' uneasiness with a craft that was not yet fully understood, suggesting that glassmaking was still a fledgling industry.[26]

Glass manufacture, as seen in the texts, made use of three types of kilns: the *kūru* kiln, which was operated with a bellows, was used for sintering; the *kūru ša takkannu*, a *kūru* kiln with a chamber, was used as a melting furnace; and the *atūnu* kiln was used for long firings.[27] The texts denote different types of crucibles, one of which could be closed with a cover, used for producing red glass.[28] Copper, a common component of glass, typically produces a green or blue color; however, when in a

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[23] Oppenheim 1988, 14-5.
[24] Moran 1992, 73.
[25] Oppenheim 1988, 28.
[26] Oppenheim 1988, 33.
[27] Oppenheim 1988, 69-70.
[28] Oppenheim 1988, 71.

reduced environment (that is, where oxygen is withheld, as would occur in a closed crucible), copper produces red glass.[29] Different kinds of tools, such as rakes and tongs, are mentioned in conjunction with testing and stirring the glass, while clay stands, *nēmedu*, supported the crucible inside the kiln.[30]

The glassmaking process began only after the kiln had been preheated for a number of hours. The soda, lime, and silica consisted of "ashes of the NAGA plant" or plant ash, lime obtained from corals or sea shells, and *immanakku* stone, probably a sandstone conglomerate with quartz pebbles.[31] These components were ground up together, then sintered and cooled; this process formed *zukû* glass, a kind of frit, which is again ground and mixed with minerals added for color.[32] This mixture was fired, sometimes for up to a week, then annealed, or slowly cooled, in the kiln for a matter of days.[33]

The Amarna letters reveal that glass was traded as a raw material. The Akkadian terms *mekku* and *ehlipakku*, believed to represent West Semitic and Hurrian terms for glass respectively, denote a commodity sent from western Asia to Egypt.[34] In *EA 323*.13-16, for example, Yidya, possibly the mayor of Ashkelon, writes to pharaoh: "As to the king, my lord's, having ordered some glass [*ehlipakku*], I {her}ewith send to the

[29] Francis 1982, 10.
[30] Oppenheim 1988, 71-2.
[31] Oppenheim 1988, 67 and 74.
[32] Oppenheim 1988, 76.
[33] Moorey 1994, 203; Oppenheim 1988, 79.
[34] Oppenheim 1973, 259-63.

k{ing}, my {l}ord, 30 (*pieces*) of glass."[35] This active trade is also reflected in the archaeological record.

Archaeological evidence for glass manufacture is rare, and existent finds are not always substantive.[36] Nevertheless, analysis of a 14th-century B.C. factory at Amarna, when combined with that of a later, Roman period factory at Jalame, provides evidence substantiating the somewhat enigmatic textual sources described above.

Glassmaking evidence from Amarna includes fritting pans, 10 inches across and 3 inches deep, found in association with cylindrical jars, down whose side glaze had dripped from bottom to top. Petrie proposes that the inverted cylindrical jars supported the fritting pans inside the kiln; if accurate, these cylindrical jars correspond to the clay stands, or *nēmedu*, of the Mesopotamian texts.[37] Nicholson, however, believes that these jars represent molds used in the manufacture of glass ingots.[38]

To test for completion and color, the texts suggest removing a pinch of glass from the crucible with pincers; Petrie's recovery of small pinches of glass confirm this procedure.[39] When finished heating, glass was cooled in the crucible which was later chipped away, along with the frothy upper layer formed by carbon dioxide.[40] Although Petrie did not recover any crucibles, residual chips were found on chunks of glass 2-3 inches in diameter and depth; it is therefore assumed that crucibles conformed to these dimensions.

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35 Moran 1992, 352.
36 Moorey 1994, 202.
37 Petrie 1974, 26.
38 Nicholson 1995, 128.
39 Petrie 1974, 26.
40 Lucas 1948, 220.

Remains of two furnaces, believed to have been used for glass making, were recently excavated at Amarna; these round, thick-walled furnaces, lined with vitreous slag, probably possessed domed tops.[41] Although from a later period, the large furnace structure uncovered at the Late Roman glass factory at Jalame, southeast of Haifa, Israel, might serve as a parallel for earlier kilns. The furnace dome was constructed of mud bricks, and the absence of an annealing oven suggests that this process was carried out at one end of the furnace.[42] Archaeologists recovered fragments of stone slabs, which were probably built into the walls of the furnace and served as a ledge on which crucibles rested.[43] Evidence suggests that the crucibles at Jalame were limestone, not ceramic, and rectangular instead of round; however, as with those at Amarna, the crucibles at Jalame were destroyed after each use.

Ingots of unworked glass provide evidence of an active trade in glass as a raw material; this trade allowed Mycenaean and other cultures to work glass to their own tastes while protecting the secrecy of the glass recipe.[44] Approximately 175 such ingots were found on the Uluburun shipwreck, in cobalt, turquoise, lavender, and amber.[45] 13 contemporary ingots of light and dark blue glass were found at the Mitanni palace at Tell Brak.[46] Later glass ingots, dating between the eighth and fourth centuries B.C., have been found at Kuyunjik, Dilbat, and Persepolis.[47]

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[41] Nicholson 1995, 127.
[42] Weinberg 1988, 33.
[43] Weinberg 1988, 31.
[44] Kurinsky 1991, 90.
[45] Pulak 2001, 25.
[46] Oates et al. 1997, 85-6.
[47] Moorey 1994, 203.

Glass Bead Manufacture

Glass working, as opposed to glassmaking, was more often performed in small, local workshops.[48] Some methods of beadmaking utilized glass canes, which are long, drawn-out rods of glass. Simple monochrome canes were created by scooping out a gob or small amount of glass on the end of a tool, then using a second tool to stretch the gob into a long, slender rod. More complex, multi-colored canes were created using the process outlined for monochrome canes, but starting with multiple gobs of differing colors which were twisted while being drawn out.[49]

Beck outlines six types of glass beads, five of which were produced during the Late Bronze Age.[50] Spaer, in her study of ancient glass beads in Israel, elaborates on these types and notes that most ancient beads were worked hot instead of cold.[51] The five types produced during the Late Bronze Age are as follows.

1. A w*ire-wound bead* was created by trailing melted glass around a wire or core.[52] Different types of winding existed, but the most common was gob winding, in which a gob of glass was picked up on one rod, then allowed to flow onto a second rod called a bead mandrel.[53] These beads often exhibit striations encircling the bead axis.[54]

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[48] Spaer 2001, 37.
[49] Colorful, spiral canes were also created using prefabricated monochrome canes (Spaer 2001, 48-9).
[50] The sixth type, blown-glass beads, utilizes a technology not yet developed during the Bronze Age. Descriptions of the remaining five types are provided by Beck (1981, 60-2).
[51] Spaer 2001, 44-5.
[52] This type corresponds to Karklins' wound beads (1985, 96-7).
[53] Beck 1981, 60; Spaer 2001, 45.
[54] Karklins 1985, 97.

2. A *folded bead* was created by folding a thick piece of softened glass around a wire or rod, then pinching it closed. Longitudinal seams are usually visible on beads formed using this method.[55]

3. A *double-strip bead*, sometimes referred to as a joined bead, consists of two pieces of glass wrapped around a rod and joined at the edges. This type is similar to the folded bead, but exhibits multiple seams.[56]

4. A *molded bead* was created by flowing molten glass into a mold, which often had channels for the insertion of a combustible core.[57] These cores burned away, forming a perforation in the bead. With a technique called "dry molding", the molds were filled with lumps of cold glass which, upon extended heating, melted and conformed to the mold.[58]

5. A *cane bead* was cut from a thin glass tube.[59] To create this tube, an air bubble was trapped in a gob of glass by either folding it and pinching it shut or piercing it with another tool and capping the end. The air-filled gob was then drawn out, forming a tubular cane. Such tubes were cut into sections when hot, with a thin rod inserted to preserve the perforation, or allowed to cool, then cut.[60] Cane beads exhibit striations parallel with the bead axis.[61] Cold cutting or cold forming of beads, although less common, did exist during the Bronze Age; forming a bead with this method is similar to

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[55] Beck 1981, 61; Spaer 2001, 45.
[56] Beck 1981, 61-2; Spaer 2001, 45.
[57] This type corresponds to Karklins' mould-pressed beads (1985, 100-1).
[58] Beck 1981, 62; Francis 1982, 5; Spaer 2001, 45.
[59] This type corresponds to Karklins' drawn beads (1985, 88-9).
[60] Beck 1981, 60-1; Spaer 2001, 47.
[61] Karklins 1985, 89.

the formation process for stone beads.[62] Cooled monochrome or multi-colored canes were cut with a sharp tool, then drilled and ground to a finish. The drilling of glass, however, frequently resulted in breakage and was typically avoided.

Ancient glass beads were not painted; most decoration consisted of other glasses, flowed onto the bead then dragged to create a swirled effect; this technique was an innovation first seen in the 16th century B.C.[63] Another innovation during this period was that of marvering, in which the glass was rolled on a flat stone surface for a smooth and even finish.[64] A crumb decoration could be added to a bead by sprinkling cold crumbs of colored glass onto the surface of the hot glass bead; these crumbs could stand out or be marvered flush with the bead surface.[65]

If left undecorated, glass beads were lightly polished through one of two means.[66] Using fire-polishing, the glass bead was temporarily exposed to direct heat, which softened and smoothed the bead surface. An alternative to fire-polishing was smoothing with a light abrasive, such as pumice, which also resulted in a smoothed bead surface.

Evidence of Glass Bead Manufacture in the Archaeological Record

Glass beads have been found in great numbers throughout the Levant; however, beads alone do not necessarily permit conclusions on their manufacture. The best source for this information is a workshop, such as the glazing and glassmaking workshop at

[62] Nicholson 1993, 57.
[63] Spaer 2001, 52; Moorey 1994, 193.
[64] Nicholson 1993, 53.
[65] Beck 1981, 62-3.
[66] Spaer 2001, 55.

Amarna; glass waste from bead manufacture found at this site serves to illustrate some of the aforementioned glass beadmaking techniques. Finds here include canes and tubes, which could have been used in the cane bead or cold-cutting techniques described above. The rolled glass rods and flattened strips were probably cut into smaller pieces, then used in folded or double-strip beads. Imperfect glass beads with trailing ends confirm the technique of winding, and unfinished beads left on a bronze or copper wire suggest that such wires formed the rod around which the glass was trailed.[67]

Although there are no remains of glass working factories at Nuzi, analysis of some of the thousands of glass beads at this site confirms the technique of winding. Vandiver notes that the beads were formed on a copper rod, two to three millimeters in diameter, coated with calcite and clay so that the beads were easier to extract upon cooling.[68] This technique, which left a rough coating on the inner core of some of the Nuzi beads, is still used in bead manufacture today.[69] The glass beads at Nuzi, noted for their vast number, also display a wide range of decoration.[70] Glass colors include green, blue, yellow, white, red, and black.[71] Decorating methods include the use of multiple colors of glass, multiple piercings, and even metallic inlays.

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[67] Petrie 1974, 26-7, pl. XIII.
[68] Vandiver 1983b, 242.
[69] Francis 1982, 7-8. Francis (1982, 5) points out, however, that, because metal contracts faster than glass, a wire-wound bead could easily be knocked off the metal rod on which it was formed.
[70] More than 16,000 beads were found in Temple A alone, the majority of these being glass beads (Starr 1939, 94).
[71] Starr 1939, 446-7; Vandiver 1983b, 240.

Manufacture of the Glass Beads Found on the Uluburun Shipwreck

The glass beads found on the Uluburun shipwreck have been identified as wire-wound based on several features including perforation deposit, striation pattern, and the presence of a peak at the bead end. Perhaps the most notable feature visible on both small and large glass beads is the opaque, beige perforation deposit (fig. 2.24). As noted above, a similar perforation deposit found in glass beads at Nuzi was identified as a combination of calcite and clay and is commonly found in wire-wound beads.[72]

The second feature, striation pattern, often aids in identifying a glass bead's manufacture technique. Wound beads exhibit striations which encircle the bead axis,[73] and such striations are visible on some of the small glass beads (fig. 2.20). These striations are, in some cases, so distinct as to suggest intentional decoration; however, as argued in chapter II, they are far more likely a result of deterioration. Although striations are not as apparent on the large glass beads due to devitrification and surface deterioration, isolated examples, such as Lot 9855.3g (figure in app. B), exhibit distinct striations which encircle the bead axis. Elongated air bubbles perpendicular to the bead axis were noted on some of the glass beads during excavation, again confirming the technique of wire-winding.[74]

The third feature common in wire-wound beads is the presence of a peak at one end, marking where the glass thread that was trailed onto the wire was severed.[75] Such peaks are common on the large glass beads and may be distinct and angular, as in Lot

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[72] Moorey 1994, 204; Vandiver 1983b, 242.
[73] Karklins 1985, 97.
[74] Pulak, personal communication.
[75] Beck 1981, 60; Petrie 1974, 27.

7100, or rounded, as in Lot 7621 (fig. 2.25). The small glass beads exhibit peaks only rarely, and these peaks are subtle and rounded as exemplified by Lot 1489.1v.

Based on the above three features, it appears that both the small and large glass beads were wire-wound. There are slight differences, however, in the overall bead form, the small glass beads being more spherical and the large beads more oblate. The small glass beads also include segmented or double beads, some of which exhibit the three wire-wound features and may thus also be classified as wound beads. However, these segmented beads may have been intended to be separated, as suggested above.[76]

The large glass beads are both more oblate and less symmetrical than the small glass beads, and this likely results from their decoration. As suggested earlier, there is a distinct possibility that all large glass beads found on the Uluburun shipwreck are eye beads, the manufacture of which was discussed above.[77] A glass bead which is decorated with spots or crumbs would have been subjected to additional manipulation as the decorative elements were added, possibly resulting in the asymmetry common in this group. Furthermore, glass must be slowly annealed in order to prevent cracking, and exposure to sudden fluctuations in temperature through the addition of cold glass crumbs, as well as the removal of the bead from heat while doing so, may have contributed to the frequent cracking and overall poor preservation which characterizes this group.

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[76] See supra 56-7.
[77] See supra 61-2, 64-5.

Finally, as noted above, the perforation on some large glass beads exhibits an angular edge at one end and a rounded, indistinct edge at the opposite end.[78] The perforation with the angular edge also tends to be slightly larger, thereby resulting in a conical (Type III) perforation. This may be due to winding on a tapered mandrel, similar to the tapered metal rods used in modern glass bead production in Turkey.[79] The rounded perforation edge, then, results from a slight pull on the glass as the bead is knocked off the mandrel, as shown in figure 5. The conical or incomplete perforations noted on some of the small glass beads are also a likely result of winding on a tapered mandrel. It remains unclear, however, whether the wound bead was formed from a prefabricated glass cane or a gob of glass straight from the furnace.

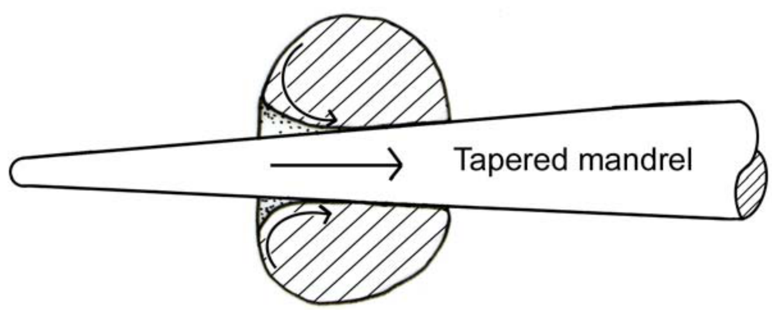

Fig. 5. Removing a wound glass bead from a tapered mandrel.

[78] See supra 60.
[79] Küçükerman 1988, 64, fig. 38, 70, fig. 43.

CHAPTER VI

SUMMARY AND CONCLUSION

By the time the Late Bronze Age vessel sank near Uluburun around 1300 B.C., both the faience and glass industries were well-established in the eastern Mediterranean. Although faience production was in a state of decline in the Aegean at that time, it was flourishing in Egypt and western Asia, under the Middle Assyrian phase of production. Similarly, glass production, although much newer than faience, was at that point a true industry experiencing a period of expansion and innovation. Within this context, it is not surprising that so large a number of faience and glass beads were included in the ship's cargo.

Approximately 75,000 faience beads were found on the Uluburun shipwreck, and they may be divided into eight categories. While the surface glaze remains in rare patches only, most faience beads exhibit a blue undertone. Other colors are visible in the tiny faience bead category only, and include red, yellow, white and turquoise. The style of most categories is relatively simple and may be found in use throughout the Levant. However, the grain-of-wheat faience beads comprise a distinctly Mycenaean type and may be attributed to that culture.

Approximately 9,500 glass beads were recovered, although, due to their poor state of preservation, the actual number carried on the ship was probably much higher. The glass beads may be roughly categorized as small and large; due to devitrification, the original color of these beads is indeterminable. Characteristics of the beads suggest that they were formed through wire-winding. The small glass beads are generally spheroid, while the large glass beads are often asymmetric and oblate. Many of the large glass beads exhibit spot or crumb decoration, or a combination of both, and there is a distinct possibility that all large glass beads were decorated in this way, but surface deterioration masks the decoration. The form of the glass beads, like that of many faience categories, is quite common throughout the Levant and may not be attributed to any particular region with certainty.

Two concreted masses of beads, one consisting solely of tiny faience beads and the other of small glass beads, provide direct evidence that these beads represent cargo. Other categories, including globular and cogwheel faience beads and large glass beads, are also designated as cargo due to a combination of factors including stylistic features, number found, and manufacturing flaws. Furthermore, analysis of the distribution pattern formed by each category of faience and glass bead on the shipwreck's site plan reveals that the beads serving as cargo were stored on the after half of the ship, and at least one category, small glass beads, was stored in a Canaanite jar.

It is clear, then, that most of the glass and faience beads found on the Uluburun shipwreck represent a small part of the ship's cargo, which, based on analysis of other finds from the shipwreck, was bound for a destination on the Greek mainland.[1] These beads do not represent a finished product; rather, they were shipped in bulk, meant to be strung by Mycenaean craftsmen in a fashion appealing to that culture. Any speculation on the intended use of these beads, then, must rely on evidence of Mycenaean styles.

[1] Pulak 1998, 219.

The wide variety of raw materials and luxury goods carried on the ship suggests that it represents gift exchange between two Late Bronze Age palatial centers.[2] This being the case, how do the glass and faience beads fit into this context? Would jewelry created from these beads be considered an indicator of high status? There is some debate on the status of glass and faience jewelry in the Aegean. Identical bead forms were often created in both gold and vitreous materials such as glass or faience,[3] leading some to speculate that the latter were cheap substitutes for the former.[4] Faience or glass beads covered in gold foil at several Mycenaean sites seem to confirm this.[5] A view of faience and glass as a substitute for more costly materials is reinforced by Mesopotamian texts, which closely link them with lapis.[6] In addition, due to the proliferation of faience and glass beads in LH IIIA-B graves, they are assigned a low status index in comparison to other bead materials.[7]

However, Nightingale notes that, although faience or glass may have been substitutes for lapis or other stones, they could never be mistaken for gold.[8] Furthermore, both materials were frequently combined, as in the faience bead with gold caps found at Hala Sultan Tekke,[9] or the gold and glass bead necklaces recovered intact at Asine.[10] The presence of faience and glass beads in several high-status Mycenaean graves further refutes the theory that these objects were cheap imitations. It is clear,

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[2] Pulak 1998, 220.
[3] Nightingale 2000, 159.
[4] Blegen and Blegen 1937, 1:253; Konstantinidi 2001, 249; Wace 1932, 206.
[5] Deutsches Archäologisches Institut 1880, 24; Persson 1931, 105; Wace 1923, 380.
[6] Oppenheim 1988, 9-14.
[7] Lewartowski 2000, 35.
[8] Nightingale 2000, 163.
[9] Åström et al. 1983, 177.
[10] Frödin and Persson 1938, 398-9.

then, that faience and glass, although less costly alternatives to gold, were valuable in their own right.[11] This being the case, a bulk shipment of faience and glass beads is consistent with the valuable raw materials and luxury goods found on the Uluburun shipwreck.

Regardless of their intended use or indication of status, the beads found on the Uluburun shipwreck comprise an important contribution to the archaeological record and bead studies in particular, for the mere fact that they may be dated by provenance alone to around 1300 B.C. For those beads representing cargo, there is no question of whether the beads were manufactured at an earlier period and handed down or reused, as is often the case with beads found in burial contexts. There has, in the past, been an assumption of local manufacture for some glass and faience beads recovered from archaeological sites in the Aegean;[12] this assumption seems logical, as the faience and glass industries in that region were certainly capable of creating such objects. The beads found on the Uluburun shipwreck, however, provide evidence that such objects, however small and simple, were also imported, and they thereby serve as a caveat against such assumptions.

Finally, it is clear that all the beads found on the Uluburun shipwreck, both cargo and personal items, represent styles in use in the Levant at the close of the 14th century B.C. The true value of these beads, and consequently that of this thesis, lies in their use as a reference for future bead research, and the catalogue presented in chapter II, combined with supplementary data in appendix B, was created to that end.

[11] Foster 1979, 156; Hughes-Brock 1999, 285; Nightingale 2000, 163-4.
[12] Blegen and Blegen 1937, 1:266.

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APPENDIX A

GLOSSARY OF TERMS

Amygdaloid
: Shaped like an almond.

Application
: A technique for glazing faience in which the surface glaze is applied to the faience body through dipping, pouring, or painting.[1]

Axis
: An imaginary line through the center of the perforation (fig. A.1).

Bicone
: Bead in which the profile consists of two straight lines, at an angle to one another, which meet the perforation; appears as two cones joined at their bases.

Cementation
: A self-glazing technique in faience manufacture in which the dried faience body is deposited in a dish containing a glazing powder; the entire dish is placed into the kiln, and, upon firing, the glazing powder melts at the surface of the faience body, forming a glaze.[2]

Collar
: Any attachment or projection at the end of the perforation.

Core
: The part of the bead lying next to the perforation.[3]

Diameter
: The maximum width of the transverse section (fig. A.1).

Disk bead
: Bead in which the length is less than one-third the diameter (or, length-to-diameter ratio is less than 0.3).

Edge
: The junction of two facets or surfaces on a bead (fig. A.1).

All terms in glossary are from Beck 1981 unless noted otherwise.
[1] Vandiver 1983a, A27-9.
[2] Vandiver 1983a, A33-8.
[3] Francis 1989, 10.

Efflorescence

A self-glazing technique in faience manufacture in which the alkaline salts present in the faience body migrate to the surface during drying and form a powdery surface layer; upon firing, this surface layer melts to form a glaze.[4]

End

The surface at the end of the perforation that is approximately flat or concave (fig. A.1).

Flute

One of a series of concave bands running longitudinally on the bead. It differs from a gadroon by being concave, whilst the gadroon is convex.

Fusiform

Shaped like a spindle.[5]

Gadroon

One of a set of raised convex curved bands, joined at their extremities to form a decorative pattern.

Length

Distance between the two ends of a bead, usually the length of the perforation (fig. A.1).

Length-to-Diameter Ratio

Calculated by dividing bead length by bead diameter. Determines whether a bead is a disc (<0.3), short (.3-.9), standard (.9-1.1), or long (>1.1).

Longitudinal View

View along the axis that shows the greatest distance from the axis to the profile.

Marver

Flat block of marble or other heat resistant surface upon which glass beads are rolled or shaped.[6] Also used as a verb for the process of rolling or shaping a bead upon such a block.

Matrix

In eye beads, the body of glass into which are impressed eyes of different colored glass.

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[4] Vandiver 1983a, A31-3.
[5] Francis 1989, 18.
[6] Francis 1989, 28.

Perforation

Hole along the bead axis by which the bead is strung (fig. A.1). Perforations in glass and faience beads at Uluburun include the following types outlined by Beck:

Type III	Conical perforation
Type IV	Plain perforation (perforation is approximately parallel)
Type VIa	Medium-large perforation, where perforation is more than one-quarter and less than one-half the diameter of the bead.
Type VIb	Extra-large perforation, where the perforation is one-half the diameter of the bead or larger.

Perforation Deposit

Residue left in a perforation from the manufacturing process.[7]

Perimeter

The line or lines bordering the transverse view (fig. A.1).

Profile

The line or lines bordering the longitudinal view, joining the two ends of the bead (fig. A.1).

Segmented bead

A family of multiple beads (XVII.A.1) in which two or more beads are joined at the ends and possess a common axis.

Spheroid

Beads belonging to group 1, family 1.a, which are spherical, or only slightly oblate or ellipsoidal, and those belonging to family 1.b, which have small ends and approximate to spheres.

Transverse view

The view of a bead perpendicular to the axis (fig. A.1).

Thickness

The lesser dimension of a grain-of-wheat variant A or B bead in transverse view (fig. A.1).

Thixotropic

A characteristic of faience, indicating that the faience paste becomes more fluid when manipulated.[8]

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[7] Francis 1989, 33.
[8] Nicholson 1993, 9.

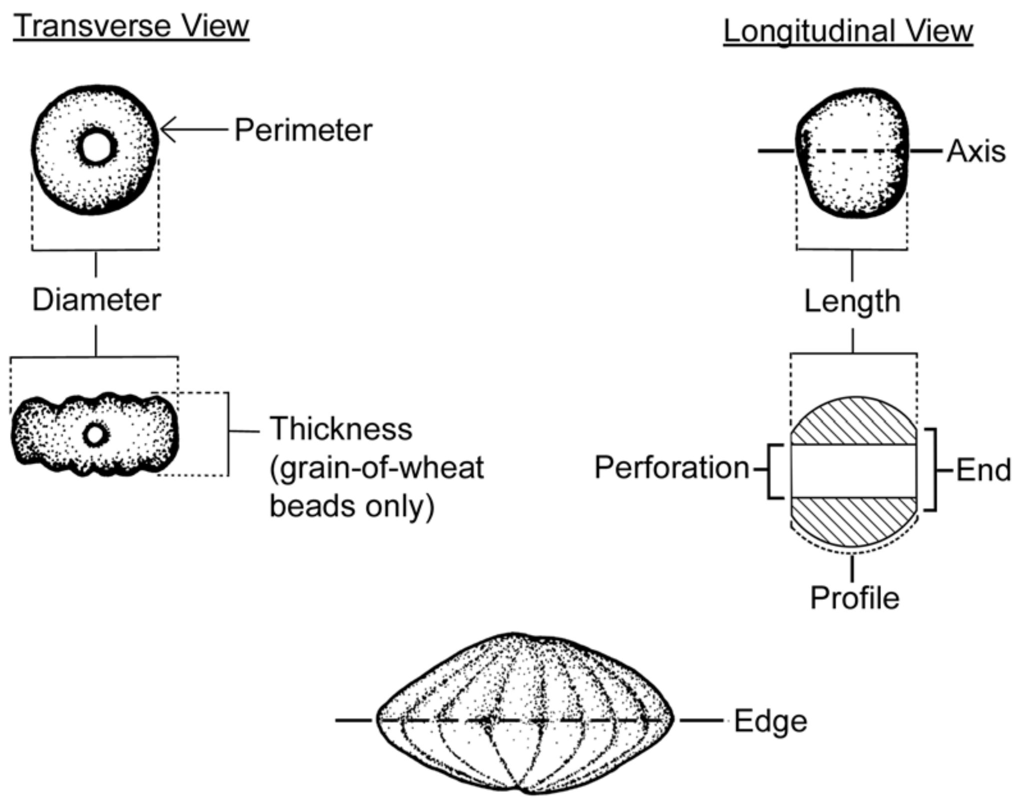

Fig. A.1. Bead terminology used in this thesis.

APPENDIX B

SAMPLE BEAD DIMENSIONS AND PHOTOGRAPHS

Table B.1. Sample dimensions of tiny faience beads.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Diam.	Length	Perf.	Location	Color	Notes
KW 988	I.B.2.b	0.25	0.10	0.10	M16 UL1	Red	
KW 1034	I.B.2.b	0.29	0.15	0.13	M15 LL3	Red	
KW 1048	I.B.2.b	0.21	0.11	0.09	M15 LL1	Blue	
Lot 5810	I.B.2.b	0.26	0.11	0.14	spoil	Red	
Lot 5969.a	I.A.1.b	0.50	0.12	0.20	M16 UL3	Yellow	
Lot 5969.b	I.A.1.b	0.32	0.09	0.16	M16 UL3	Yellow	
Lot 5969.c	I.B.1.b	0.24	0.12	0.12	M16 UL3	Yellow	
Lot 5969.d	I.B. 2.b	0.29	0.13	0.13	M16 UL3	Yellow	
Lot 5969.e	I.B.1.b	0.25	0.11	0.12	M16 UL3	Red	
Lot 5969.f	I.B.2.b	0.30	0.16	0.12	M16 UL3	Red	
Lot 7342.a	I.B.2.b	0.23	0.11	0.14	J21 R	Red	
Lot 7342.b	XVII.A.1.a	0.25	0.24	0.12	J21 R	Red	2 segments
Lot 8788.a	I.B.2.b	0.30	0.12	0.13	N16 LL3	Yellow	
Lot 8788.b	I.B.1.b	0.28	0.20	0.08	N16 LL3	Red	
Lot 8788.c	I.A.2.b	0.37	0.10	0.17	N16 LL3	Green-white	
Lot 8788.d	I.B.1.b	0.28	0.10	0.12	N16 LL3	White	
Lot 8788.e	XVII.A.1.a	0.27	0.23	0.13	N16 LL3	White	2 segments
Lot 8788.f	I.B.1.b	0.23	0.08	0.11	N16 LL3	Blue	
Lot 8788.g	I.B.2.b	0.21	0.13	0.10	N16 LL3	Blue	
Lot 8788.h	I.B.1.b	0.25	0.13	0.10	N16 LL3	Red	
Lot 8788.i	I.B.1.b	0.23	0.10	0.13	N16 LL3	Red	Joined to Lot 8788.j
Lot 8788.j	I.B.1.b	0.23	0.08	0.09	N16 LL3	Red	Joined to Lot 8788.i
Lot 8811.a	I.B.2.b	0.25	0.12	0.11	O17 LR4	Red	
Lot 8811.b	XVII.A.1.a	0.23	0.23	0.11	O17 LR4	Red	2 segments
Lot 9160.a	I.B.2.b	0.24	0.10	0.11	M15 LR3	Turquoise	
Lot 9160.b	I.B.1.b	0.28	0.10	0.11	M15 LR3	Green-white	
Lot 9160.c	I.B.2.b	0.28	0.11	0.12	M15 LR3	Yellow	
Lot 9160.d	I.B.1.b	0.23	0.11	0.10	M15 LR3	Red	
Lot 9160.e	I.B.2.b	0.21	0.16	0.11	M15 LR3	Red	
Lot 9160.f	XVII.A.1.a	0.25	0.25	0.12	M15 LR3	Red	2 segments
Lot 9160.g	XVII.A.1.a	0.24	0.22	0.09	M15 LR3	Red	2 segments
Lot 9160.h	XVII.A.1.a	0.23	0.22	0.08	M15 LR3	Red	2 segments
Lot 9160.i	I.B.2.b	0.25	0.11	0.12	M15 LR3	Red	Joined to Lot 9160.j
Lot 9160.j	I.B.2.b	0.24	0.09	0.13	M15 LR3	Red	Joined to Lot 9160.i
Lot 9271.a	I.B.2.b	0.22	0.09	0.12	O17 LR1	Blue	Joined to Lot 9271.b-c
Lot 9271.b	I.B.2.b	0.19	0.10	0.10	O17 LR1	Blue	Joined to Lot 9271.a, c

Table B.1 Continued

Inv. No.	Beck No.	Diam.	Length	Perf.	Location	Color	Notes
Lot 9271.c	I.B.2.b	0.17	0.09	0.08	O17 LR1	Blue	Joined to Lot 9271.a-b
Lot 9271.d	I.B.1.b	0.24	0.11	0.10	O17 LR1	Red	
Lot 9271.e	I.B.2.b	0.19	0.10	0.10	O17 LR1	Red	
Lot 9576.a	I.B.2.b	0.34	0.12	0.20	N16 LR3	White	
Lot 9576.b	I.A.2.b	0.43	0.13	0.23	N16 LR3	Grey	
Lot 9576.c	I.B.2.b	0.26	0.11	0.14	N16 LR3	Red	
Lot 9576.d	I.B.2.b	0.27	0.10	0.16	N16 LR3	Turquoise	
Lot 9576.e	I.B.2.b	0.24	0.12	0.14	N16 LR3	Blue	
Lot 9576.f	XVII.A.1.a	0.21	0.40	0.10	N16 LR3	Red	3 segments
Lot 10314.a	I.B.1.b	0.26	0.09	0.11	N16 LL	Red	
Lot 10314.b	I.B.1.b	0.35	0.12	0.18	N16 LL	Red	
Lot 10314.c	I.B.2.b	0.24	0.11	0.11	N16 LL	Red	
Lot 10314.d	I.A.1.b	0.30	0.09	0.11	N16 LL	Red	Joined to Lot 10314.e
Lot 10314.e	I.B.1.b	0.30	0.11	0.10	N16 LL	Red	Joined to Lot 10314.d
Lot 10314.f	I.B.1.b	0.31	0.12	0.10	N16 LL	Yellow	
Lot 10314.g	I.B.2.b	0.26	0.12	0.12	N16 LL	Green-white	
Lot 10314.h	I.B.2.b	0.23	0.09	0.10	N16 LL	Turquoise	
Lot 10314.i	I.B.2.b	0.21	0.10	0.12	N16 LL	Turquoise	
Lot 10314.j	I.A.1.b	0.32	0.09	0.16	N16 LL	Blue-black	
Lot 10314.k	I.B.1.b	0.28	0.12	0.09	N16 LL	Black	
Lot 10314.m	XVII.A.1.a	0.27	0.20	0.12	N16 LL	Red	2 segments
Lot 10314.n	I.C.2.b	0.24	0.27	0.11	N16 LL	Red	
Lot 10314.p	I.B.1.b	0.26	0.12	0.13	N16 LL	Red	
Lot 10314.q	I.B.1.b	0.27	0.13	0.11	N16 LL	Red	
Lot 10314.r	I.B.1.b	0.26	0.15	0.12	N16 LL	Green-white	
Lot 10314.s	I.B.2.b	0.24	0.10	0.10	N16 LL	Blue	
Lot 10314.t	I.B.2.b	0.21	0.10	0.11	N16 LL	Blue	Joined to Lot 10314.u
Lot 10314.u	I.B.2.b	0.21	0.10	0.13	N16 LL	Blue	Joined to Lot 10314.t
Lot 10314.v	I.B.2.b	0.26	0.16	0.11	N16 LL	Green	Joined to Lot 10314.w
Lot 10314.w	I.B.2.b	0.26	0.15	0.11	N16 LL	Green	Joined to Lot 10314.v
Lot 10314.x	I.B.2.b	0.23	0.11	0.10	N16 LL	Red	Joined to Lot 10314.y-z
Lot 10314.y	I.B.2.b	0.24	0.10	0.12	N16 LL	Red	Joined to Lot 10314.x, z
Lot 10314.z	I.B.2.b	0.24	0.10	0.09	N16 LL	Red	Joined to Lot 10314.x-y
Lot 10315.a	I.B.1.b	0.37	0.12	0.22	N16 LL	Red-brown	
Lot 10315.b	I.A.1.b	0.42	0.09	0.22	N16 LL	Yellow	
Lot 10315.c	I.B.1.b	0.42	0.16	0.17	N16 LL	Black	
Lot 10315.d	I.A.2.b	0.38	0.11	0.16	N16 LL	Blue	
Lot 10315.e	I.B.1.b	0.53	0.17	0.20	N16 LL	Greenish	
Lot 10315.f	I.B.2.b	0.42	0.13	0.21	N16 LL	White	
Lot 10315.g	I.B.2.b	0.20	0.09	0.10	N16 LL	Blue	
Lot 10315.h	I.B.2.b	0.22	0.10	0.12	N16 LL	Blue	
Lot 10315.i	I.B.2.b	0.27	0.15	0.13	N16 LL	White	

Table B.1 Continued

Inv. No.	Beck No.	Diam.	Length	Perf.	Location	Color	Notes
Lot 10315.j	I.B.2.b	0.27	0.18	0.12	N16 LL	Greenish	
Lot 10315.k	I.B.1.b	0.26	0.12	0.11	N16 LL	Red	
Lot 10315.m	I.B.2.b	0.28	0.12	0.10	N16 LL	Red	
Lot 10315.n	I.B.1.b	0.29	0.11	0.12	N16 LL	Yellow	
Lot 10623.a	I.B.2.b	0.43	0.14	0.24	M16 UR	Yellow	
Lot 10623.b	I.B.2.b	0.19	0.11	0.10	M16 UR	Red	
Lot 10623.c	I.B.2.b	0.23	0.08	0.12	M16 UR	Blue	
Lot 10623.d	I.B.1.b	0.23	0.10	0.11	M16 UR	Turquoise	
Lot 10623.e	I.B.2.b	0.20	0.09	0.11	M16 UR	Blue	Joined to Lot 10623.f-g
Lot 10623.f	I.B.2.b	0.20	0.09	0.11	M16 UR	Blue	Joined to Lot 10623.e, g
Lot 10623.g	I.B.2.b	0.20	0.08	0.11	M16 UR	Blue	Joined to Lot 10623.e-f
Lot 10623.h	I.B.1.b	0.23	0.10	0.10	M16 UR	Blue	Joined to Lot 10623.i
Lot 10623.i	XVII.A.1.a	0.24	0.23	0.09	M16 UR	Blue	2 segments; joined to Lot 10623.h
Lot 11437.a	I.B.2.b	0.31	0.19	0.11	M16 UL3	Red	
Lot 11437.b	I.B.2.b	0.27	0.16	0.11	M16 UL3	Red	
Lot 11437.c	I.B.1.b	0.30	0.14	0.11	M16 UL3	Yellow	
Lot 11437.d	I.B.2.b	0.22	0.11	0.11	M16 UL3	Blue	
Lot 11437.e	I.A.1.b	0.36	0.10	0.16	M16 UL3	Blue-white	
Lot 11437.f	I.A.1.b	0.37	0.09	0.17	M16 UL3	Yellow	
Lot 11437.g	XVII.A.1.a	0.23	0.23	0.10	M16 UL3	Red	2 segments
Lot 11437.h	XVII.A.1.a	0.25	0.35	0.11	M16 UL3	Red	3 segments
Lot 11437.i	XVII.A.1.a	0.18	0.44	0.08	M16 UL3	Red	3 segments

Average diameter: 0.27 cm
Average length: 0.12 cm (excludes segmented bead lengths)
Average perforation: 0.12 cm

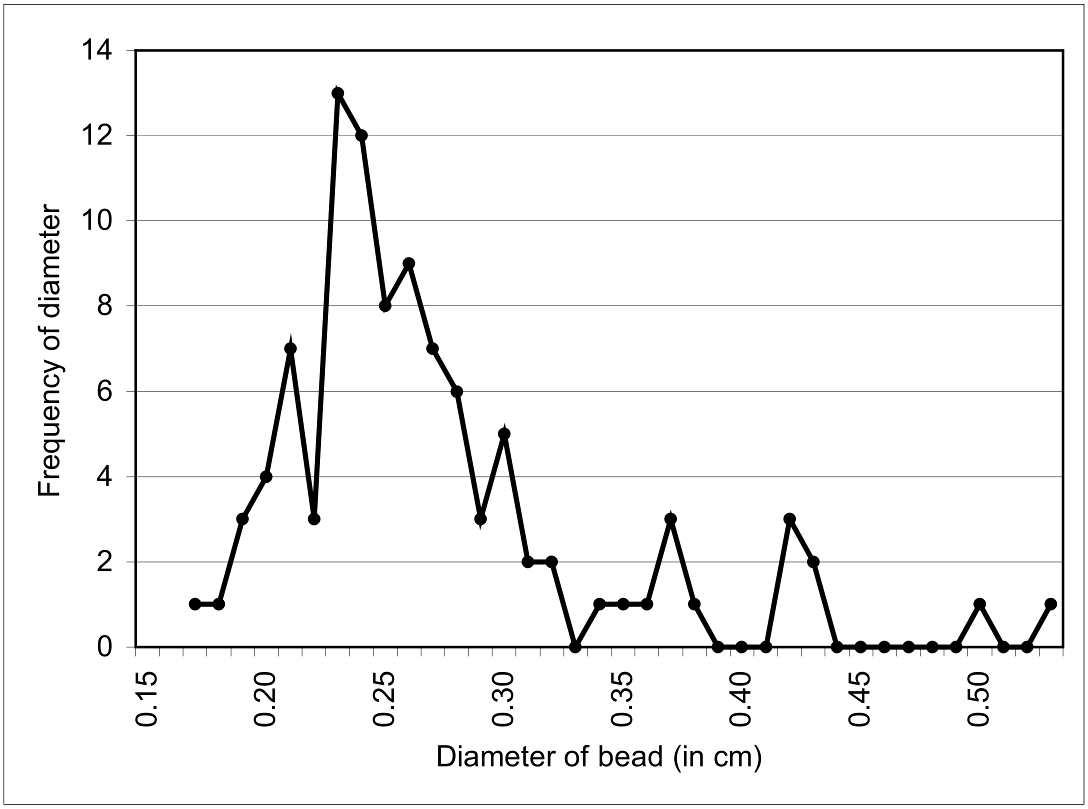

Fig. B.1. Distribution of sample tiny faience bead diameters.

Fig. B.2. Tiny faience beads KW 988 - Lot 9160.e. Scale 3:1.

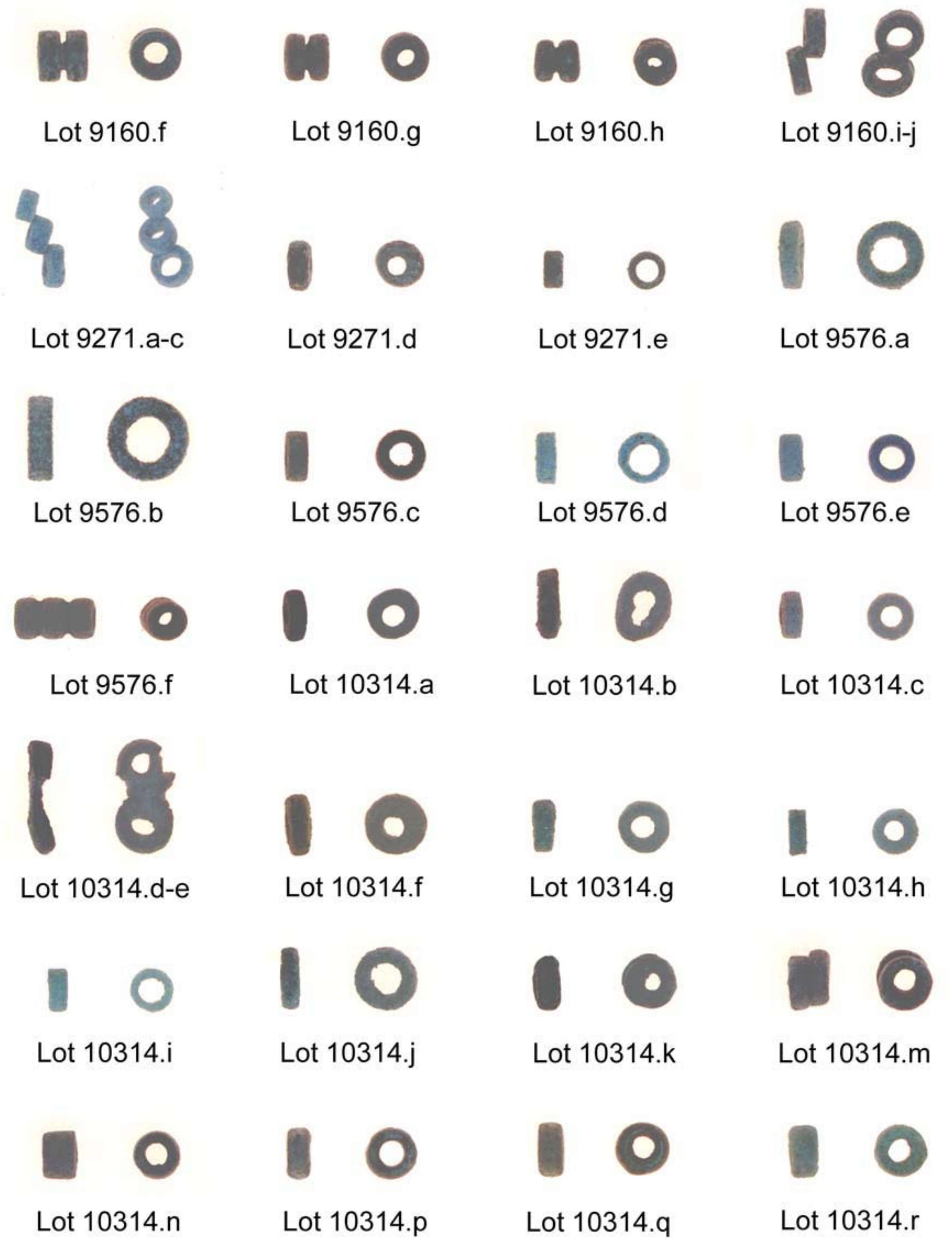

Fig. B.3. Tiny faience beads Lot 9160.f - Lot 10314.r. Scale 3:1.

Fig. B.4. Tiny faience beads Lot 10314.s - Lot 11437.e. Scale 3:1.

Fig. B.5. Tiny faience beads Lot 11437.f - Lot 11437.i. Scale 3:1.

Table B.2. Sample dimensions of globular faience beads.
All measurements are provided in centimeters

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Location	Notes
KW 2216	I.B.1.b	0.63	0.47	0.15	0.15	M15 LL4	
KW 2473	I.B.1.b	0.60	0.48	0.16	0.16	L16 UR1	
KW 2709	I.B.1.b	0.56	0.34	0.18	0.19	N15 LR2	
KW 2710	I.B.1.a	0.56	0.36	0.20	0.20	N15 LR2	
KW 2724	I.B.1.a	0.50	0.32	0.15	0.15	N15 LR2	Joined to KW 2725
KW 2725	I.B.1.b	0.48	0.35	0.14	N/A	N15 LR2	Joined to KW 2724
KW 2778	I.B.1.a	0.54	0.30	0.17	0.17	O15 LL3	
KW 2805	I.B.1.a	0.53	0.35	0.17	0.17	N15 LR4	
KW 2844	I.B.1.b	0.52	0.37	0.20	0.20	N15 LR4	
KW 3133	I.C.1.a	0.45	0.46	0.18	0.18	J21 UR4	
KW 3242	I.C.1.a	0.47	0.45	0.16	0.15	N18 UR1	
KW 3245	I.B.1.a	0.53	0.40	0.16	0.15	N18 UR1	
KW 3257	I.B.1.a	0.53	0.38	0.19	0.19	N18 UR3	
KW 3272	I.B.1.a	0.56	0.42	0.16	0.16	N18 UR3	
KW 3288	I.C.1.a	0.50	0.51	0.20	0.21	N18 UR3	
KW 3313	I.C.1.a	0.49	0.45	0.16	0.17	N18 UR3	
KW 3638	I.B.1.b	0.46	0.37	0.16	0.15	N16 LL3	
KW 3727	I.B.1.b	0.57	0.44	0.21	0.21	N16 LL3	
KW 3732	I.B.1.a	0.60	0.42	0.16	0.16	N16 LL3	
KW 3733	I.B.1.a	0.57	0.45	0.19	0.19	N16 LL3	
KW 3803	I.B.1.b	0.57	0.44	0.19	0.19	M15 LR3	
KW 3816	I.B.1.b	0.61	0.40	0.16	0.16	N16 LL3	
KW 3817	I.B.1.a	0.54	0.40	0.16	0.16	N16 LL3	
KW 3847	I.B.1.a	0.57	0.42	0.14	0.13	M15 LR4	
KW 3865	I.B.1.a	0.57	0.36	0.17	0.16	N16 LL3	
KW 3956	I.B.1.b	0.56	0.36	0.16	0.16	N16 LL4	
KW 3960	I.B.1.a	0.50	0.39	0.16	0.15	N16 LL4	
KW 3967	I.B.1.a	0.50	0.40	0.14	0.14	N16 LL4	
KW 3980	I.B.1.a	0.56	0.47	0.19	0.19	N18 LR2	
KW 3982	I.C.1.a	0.53	0.48	0.18	0.18	M16 UR4	
KW 3986	I.C.1.a	0.44	0.42	0.17	0.17	O17 LL2	
KW 3989	I.B.1.a	0.53	0.38	0.21	0.20	N16 LL4	
KW 3992	I.B.1.a	0.57	0.47	0.19	0.18	N16 LL4	
KW 3996	I.B.1.b	0.51	0.37	0.19	0.19	M16 UL2	
KW 4018	I.B.1.a	0.56	0.41	0.16	0.16	N16 U	
KW 4024	I.B.1.a	0.47	0.36	0.20	0.19	N16 U	
KW 4025	I.B.1.a	0.58	0.45	0.18	0.18	N16 U	
KW 4030	I.B.1.a	0.53	0.40	0.19	0.19	N16 U	
KW 4033	I.B.1.a	0.67	0.49	0.20	0.19	N16 U	
KW 4035	I.B.1.a	0.58	0.44	0.18	0.18	N16 U	

Table B.2 Continued

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Location	Notes
KW 4036	I.B.1.a	0.53	0.40	0.17	0.17	N16 U	
KW 4040	I.B.1.b	0.61	0.36	0.18	0.19	N16 U	
KW 4044	I.C.1.a	0.50	0.54	0.16	0.16	N16 U	
KW 4048	I.B.1.b	0.57	0.41	0.16	0.15	N16 U	
KW 4050	I.B.1.b	0.51	0.33	0.15	0.14	N16 U	
KW 4055	I.C.1.a	0.46	0.43	0.15	0.14	N16 U	
KW 4057	I.C.1.a	0.60	0.60	0.22	0.15	N16 U	
KW 4059	I.B.1.a	0.59	0.50	0.18	0.19	N16 U	
KW 4062	I.C.1.a	0.44	0.40	0.17	0.17	N16 U	
KW 4065	I.C.1.a	0.51	0.47	0.19	0.18	N16 U	
KW 4068	I.B.1.a	0.51	0.39	0.18	0.18	N16 U	
KW 4078	I.B.1.b	0.47	0.40	0.17	0.17	N16 U	
KW 4080	I.B.1.a	0.58	0.44	0.15	0.15	N16 U	
KW 4084	I.B.1.a	0.55	0.40	0.18	0.18	N16 U	
KW 4110	I.B.1.a	0.49	0.39	0.17	0.17	N16 UR3	
KW 4124	I.B.1.a	0.46	0.37	0.17	0.17	N16 UL4 / LL2	
KW 4129	I.C.1.a	0.51	0.51	0.16	0.15	P16 UL3	
KW 4131	I.C.1.b	0.60	0.55	0.18	0.19	N16	
KW 4141	I.C.1.a	0.51	0.53	0.17	0.17	N16	
KW 4147	I.B.1.a	0.63	0.50	0.18	0.18	N16	
KW 4148	I.B.1.b	0.52	0.43	0.16	0.15	N16	
KW 4150	I.B.1.a	0.52	0.31	0.21	0.20	N16	
KW 4152	I.B.1.b	0.59	0.41	0.15	0.15	N16	
KW 4155	I.B.1.a	0.56	0.36	0.19	0.19	N16	
KW 4156	I.B.1.b	0.51	0.41	0.17	0.17	N16	
KW 4162	I.B.1.a	0.50	0.39	0.20	0.20	N16	
KW 4602	I.C.1.b	0.51	0.50	0.20	0.25	N16 LL	
KW 5855	I.B.1.b	0.52	0.46	0.18	0.17	N17 LR1	
Lot 7884	I.B.1.a	0.54	0.44	0.21	0.20	N18 UR3	
Lot 10122	I.B.1.b	0.51	0.39	0.22	0.21	N17 UR4	
Lot 10314.a	I.B.1.a	0.53	0.38	0.18	0.19	N16 LL	
Lot 10314.b	I.B.1.b	0.66	0.50	0.17	0.16	N16 LL	
Lot 10314.c	I.B.1.b	0.52	0.44	0.20	0.20	N16 LL	
Lot 10314.d	I.B.1.a	0.46	0.30	0.15	0.14	N16 LL	
Lot 10314.e	I.B.1.a	0.53	0.37	0.18	0.18	N16 LL	
Lot 10314.f	I.B.1.a	0.48	0.41	0.15	0.15	N16 LL	
Lot 10314.g	I.B.1.a	0.62	0.42	0.21	0.19	N16 LL	
Lot 10314.h	I.B.1.a	0.58	0.50	0.23	0.21	N16 LL	
Lot 10314.i	I.B.1.b	0.44	0.38	0.17	0.16	N16 LL	
Lot 10314.j	I.B.1.b	0.48	0.40	0.17	0.17	N16 LL	
Lot 10314.k	I.B.1.a	0.66	0.44	0.16	0.15	N16 LL	
Lot 10314.m	I.B.1.a	0.57	0.45	0.16	0.16	N16 LL	

Table B.2 Continued

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Location	Notes
Lot 10314.n	I.B.1.a	0.56	0.36	0.21	0.20	N16 LL	
Lot 10314.p	I.B.1.a	0.57	0.42	0.17	0.17	N16 LL	
Lot 10314.q	I.B.1.b	0.64	0.42	0.22	0.22	N16 LL	
Lot 10314.r	I.B.1.b	0.62	0.49	0.21	0.19	N16 LL	
Lot 10314.s	I.C.1.b	0.53	0.48	0.18	0.18	N16 LL	
Lot 10314.u	I.B.1.a	0.50	0.43	0.18	0.18	N16 LL	
Lot 10314.v	I.B.1.a	0.57	0.37	0.22	0.21	N16 LL	
Lot 10314.w	I.B.1.a	0.49	0.33	0.16	0.16	N16 LL	
Lot 10516	I.B.1.a	0.66	0.31	0.21	0.21	N19 UL2	
Lot 10545.a	I.B.1.a	0.57	0.43	0.18	0.16	N16 LR	
Lot 10545.b	I.B.1.b	0.58	0.41	0.15	0.15	N16 LR	
Lot 10545.c	I.C.1.b	0.51	0.47	0.22	0.22	N16 LR	
Lot 10652.a	I.C.1.a	0.53	0.56	0.15	0.15	M16 LR2	
Lot 10652.b	I.B.1.b	0.52	0.44	0.18	0.18	M16 LR2	
Lot 10652.c	I.B.1.a	0.58	0.50	0.19	0.18	M16 LR2	
Lot 10652.d	I.B.1.a	0.66	0.37	0.18	0.18	M16 LR2	
Lot 10725.a	I.B.1.b	0.75	0.45	0.19	0.19	N16 LL1	Joined to Lot 10725.b
Lot 10725.b	I.B.1.a	0.56	0.45	0.14	N/A	N16 LL1	Joined to Lot 10725.a

Average diameter: 0.54 cm
Average length: 0.42 cm
Average perforation diameter: 0.18 cm

Fig. B.6. Globular faience beads KW 2216 - KW 3865. Scale 2:1.

Fig. B.7. Globular faience beads KW 3956 - KW 4062. Scale 2:1.

Fig. B.8. Globular faience beads KW 4065 - Lot 10314.c. Scale 2:1.

Fig. B.9. Globular faience beads Lot 10314.d - Lot 10652.c. Scale 2:1.

Fig. B.10. Globular faience beads Lot 10652.d - Lot 10725.b. Scale 2:1.

Table B.3. Sample dimensions of cogwheel faience beads.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Flutes	Location	Notes
KW 834	XXIII.A.2.a	0.68	0.45	0.19	0.20	5	M15 LL1	
KW 1216	XXIII.A.2.a	0.75	0.79	0.18	0.17	6	L15 UL	
KW 1570	XXIII.A.2.a	0.68	0.47	0.20	0.20	5	L16 UR1	
KW 1893	XXIII.A.2.a	0.69	0.71	0.25	0.25	6	L16 UL1	
KW 2153	XXIII.A.2.a	0.71	0.67	0.18	0.18	6	M16 UL1	
KW 2399	XXIII.A.2.a	0.58	0.54	0.18	0.17	5	M16 UL4	
KW 2471	XXIII.A.2.a	0.68	0.50	0.21	0.20	6	L16 UR1	
KW 2496	XXIII.A.2.a	0.66	0.51	0.23	0.23	5	L16 UR1	
KW 2500	XXIII.A.2.a	0.64	0.46	0.21	0.21	5	L16 UR1	
KW 3175	XXIII.A.2.a	0.64	0.49	0.22	0.21	5	N18 UR3	
KW 3198	XXIII.A.2.a	0.63	0.49	0.24	0.23	5	O19 UL3	
KW 3239	XXIII.A.2.a	0.89	0.51	0.27	0.26	7	N18 UR1	
KW 3268	XXIII.A.2.a	0.79	0.43	0.21	0.20	6	N18 UR3	
KW 3269	XXIII.A.2.a	0.64	0.50	0.21	0.20	5	N18 UR3	
KW 3317	XXIII.A.2.a	0.70	0.41	0.18	N/A	4	N18 UL2	
KW 3607	XXIII.A.2.a	0.65	0.47	0.23	0.23	5	O20 LL1	
KW 3643	XXIII.A.2.a	0.64	0.46	0.19	0.18	5	N21 UR1/3	
KW 3668	XXIII.A.2.a	0.58	0.44	0.19	0.18	5	P18 UL2	
KW 3681	XXIII.A.2.a	0.62	0.41	0.20	0.20	5	O20 UL3	
KW 3684	XXIII.A.2.a	0.64	0.48	0.19	0.20	5	O20 UL3	
KW 3721	XXIII.A.2.a	0.58	0.78	0.16	0.16	4	N16 LL3	
KW 3722	XXIII.A.2.a	0.62	0.58	0.16	0.16	8	N16 LL3	
KW 3724	XXIII.A.2.a	0.66	0.42	0.22	0.23	7	N16 LL3	
KW 3751	XXIII.A.2.a	0.62	0.47	0.21	0.21	5	L15 LR3	
KW 3781	XXIII.A.2.a	0.70	0.46	0.21	0.22	6	N16 LL3	
KW 3827	XXIII.A.2.a	0.71	0.46	0.25	0.25	5	N16 LL3	
KW 3903	XXIII.A.2.a	0.65	0.52	0.18	0.19	5	O17 LR1	
KW 3908	XXIII.A.2.a	0.64	0.44	0.21	0.30	5	N20	
KW 3916	XXIII.A.2.a	0.80	0.54	0.22	0.23	8	M15 LL4	
KW 3938	XXIII.A.2.a	0.60	0.48	0.21	0.21	5	N22	
KW 3964	XXIII.A.2.a	0.61	0.42	0.20	0.21	5	N16 LL4	
KW 3975	XXIII.A.2.a	0.64	0.44	0.17	0.16	5	O18 LL4	
KW 4072	XXIII.A.2.a	0.74	0.44	0.25	0.25	5	N16 U	
KW 4301	XXIII.A.2.a	0.65	0.47	0.22	0.21	5	N20 UR	
KW 4324	XXIII.A.2.a	0.68	0.52	0.22	0.22	5	N22 LL	
KW 4509	XXIII.A.2.a	0.64	0.51	0.18	0.17	5	N20 UR	
KW 4569	XXIII.A.2.a	0.66	0.47	0.21	0.21	4	N18	
KW 4607	XXIII.A.2.a	0.63	0.58	0.16	0.16	6	L16 UL4	
KW 4627	XXIII.A.2.a	0.73	0.62	0.19	0.17	6	N17 LR2	
KW 4771	XXIII.A.2.a	0.86	0.58	0.22	0.21	6	N18 UR3	

Table B.3 Continued

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Flutes	Location	Notes
KW 4782	XXIII.A.2.a	0.71	0.45	0.23	0.22	5	M16 UR	
KW 4786	XXIII.A.2.a	0.71	0.49	0.23	0.22	6	N17 UL1	
KW 4788	XXIII.A.2.a	0.78	0.64	0.21	0.20	5	N17 UL1	
KW 4790	XXIII.A.2.a	0.64	0.42	0.20	0.20	5	N17 UL1	
KW 4798	XXIII.A.2.a	0.63	0.59	0.20	0.22	5	N18 UR2	
KW 4800	XXIII.A.2.a	0.75	0.62	0.18	0.18	7	N17 UL	
KW 4801	XXIII.A.2.a	0.67	0.43	0.25	0.24	5	N17 UL	
KW 4879	XXIII.A.2.a	0.69	0.56	0.18	0.18	5	M15 LL1	
KW 4892	XXIII.A.2.a	0.72	0.52	0.25	0.25	5	N16 LL1	
KW 4893	XXIII.A.2.a	0.71	0.57	0.19	0.20	5	N16 LL1	
KW 4895	XXIII.A.2.a	0.70	0.52	0.24	0.24	5	N16 LL1	
KW 4919	XXIII.A.2.a	0.72	0.47	0.23	0.23	6	M16 LR4	
KW 4962	XXIII.A.2.a	0.72	0.55	0.18	0.18	7	M15 LL4	
KW 4987	XXIII.A.2.a	0.66	0.57	0.20	0.20	6	M15 LL3	
KW 4999	XXIII.A.2.a	0.63	0.49	0.19	0.19	5	M16 LR1	
KW 5000	XXIII.A.2.a	0.62	0.46	0.20	0.19	3	M16 LR1	
KW 5019	XXIII.A.2.a	0.68	0.70	0.19	0.19	6	L16 UR1	
KW 5020	XXIII.A.2.a	0.63	0.48	0.20	0.21	5	L16 UR1	
KW 5021	XXIII.A.2.a	0.60	0.61	0.21	0.21	6	L16 UR1	
KW 5022	XXIII.A.2.a	0.69	0.56	0.18	0.17	7	L16 UR1	
KW 5024	XXIII.A.2.a	0.63	0.45	0.23	0.23	5	L16 UR1	
KW 5034	XXIII.A.2.a	0.84	0.61	0.19	0.20	7	M15 LL4	
KW 5035	XXIII.A.2.a	0.59	0.45	0.21	0.21	5	M15 LL4	
KW 5049	XXIII.A.2.a	0.64	0.63	0.24	0.23	6	M15 LL4	
KW 5059	XXIII.A.2.a	0.69	0.47	0.20	0.20	5	M16 LL1	
KW 5061	XXIII.A.2.a	0.62	0.50	0.18	0.19	5	M16 LL1	
KW 5077	XXIII.A.2.a	0.66	0.44	0.22	0.21	5	M16 LR2	
KW 5080	XXIII.A.2.a	0.70	0.41	0.18	0.18	5	M15 LL4	
KW 5099	XXIII.A.2.a	0.75	0.43	0.25	0.26	6	M16 LR2	
KW 5103	XXIII.A.2.a	0.62	0.58	0.18	0.18	5	M16 LR2	
KW 5201.a	XXIII.A.2.a	0.62	0.45	0.18	N/A	5	M15 LL1	Joined to KW 5201.b
KW 5201.b	XXIII.A.2.a	0.60	0.44	0.18	N/A	5	M15 LL1	Joined to KW 5201.a
KW 5391	XXIII.A.2.a	0.96	0.58	0.30	0.34	9	M16 LR4	
KW 5507	XXIII.A.2.a	0.78	0.68	0.32	0.23	6	M16 LR	
KW 5671.a	XXIII.A.2.a	0.66	0.47	0.19	N/A	5	M16 LL2	Joined to KW 5671.b
KW 5671.b	XXIII.A.2.a	0.64	0.45	0.18	N/A	5	M16 LL2	Joined to KW 5671.a
Lot 11409.a	XXIII.A.2.a	0.65	0.53	0.17	0.17	6	M16 LL4	
Lot 11409.b	XXIII.A.2.a	0.79	0.61	0.26	0.26	6	M16 LL4	
Lot 11409.c	XXIII.A.2.a	0.61	0.47	0.22	0.21	5	M16 LL4	

Table B.3 Continued

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Flutes	Location	Notes
Lot 11409.d	XXIII.A.2.a	0.65	0.47	0.22	0.22	4	M16 LL4	
Lot 11409.e	XXIII.A.2.a	0.63	0.59	0.19	0.18	6	M16 LL4	
Lot 11435.a	XXIII.A.2.a	0.64	0.47	0.19	0.20	5	M16 UL3	
Lot 11435.b	XXIII.A.2.a	0.76	0.55	0.19	0.20	7	M16 UL3	
Lot 11435.c	XXIII.A.2.a	0.75	0.63	0.20	0.20	6	M16 UL3	
Lot 11435.d	XXIII.A.2.a	0.67	0.41	0.21	0.21	5	M16 UL3	
Lot 11435.e	XXIII.A.2.a	0.62	0.49	0.22	0.22	5	M16 UL3	
Lot 11435.f	XXIII.A.2.a	0.76	0.60	0.18	0.18	6	M16 UL3	
Lot 11435.g	XXIII.A.2.a	0.69	0.48	0.20	0.20	5	M16 UL3	
Lot 11435.h	XXIII.A.2.a	0.56	0.38	0.21	0.21	5	M16 UL3	
Lot 11435.i	XXIII.A.2.a	0.59	0.45	0.21	0.21	5	M16 UL3	
Lot 11459.a	XXIII.A.2.a	0.82	0.51	0.19	0.19	7	M16 UL4	
Lot 11459.b	XXIII.A.2.a	0.78	0.54	0.18	0.18	7	M16 UL4	
Lot 11459.c	XXIII.A.2.a	0.66	0.60	0.15	0.15	6	M16 UL4	
Lot 11459.d	XXIII.A.2.a	0.61	0.48	0.25	0.25	7	M16 UL4	
Lot 11459.e	XXIII.A.2.a	0.60	0.48	0.22	0.22	5	M16 UL4	
Lot 11459.f	XXIII.A.2.a	0.65	0.50	0.16	0.18	6	M16 UL4	
Lot 11475.a	XXIII.A.2.a	0.70	0.58	0.18	0.19	5	M16 UL4	
Lot 11475.b	XXIII.A.2.a	0.62	0.39	0.25	0.25	5	M16 UL4	
Lot 11475.c	XXIII.A.2.a	0.69	0.55	0.20	0.20	6	M16 UL4	
Lot 11475.d	XXIII.A.2.a	0.69	0.50	0.18	0.18	6	M16 UL4	

Average diameter:	0.68 cm
Average length:	0.52 cm
Average perforation diameter:	0.21 cm
Average number of flutes:	5-6

Fig. B.11. Cogwheel faience beads KW 834 - KW 3721. Scale 2:1.

Fig. B.12. Cogwheel faience beads KW 3722 - KW 4786. Scale 2:1.

Fig. B.13. Cogwheel faience beads KW 4788 - KW 5035. Scale 2:1.

Fig. B.14. Cogwheel faience beads KW 5049 - Lot 11435.e. Scale 2:1.

Fig. B.15. Cogwheel faience beads Lot 11435.f - Lot 11475.d. Scale 2:1.

Table B.4. Sample dimensions of collared cogwheel faience beads.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Diam.	Length	Collar Diam.	Perf.	Flutes	Location	Notes
KW 3204	XXIII.A.2.a, collared	0.62	0.63	0.45	0.19	6	O19 LL1	
KW 3314	XXIII.A.2.a, collared	0.68	0.58	0.47	0.21	6	N18 UR3	
KW 3478	XXIII.A.2.a, collared	0.73	0.62	0.50	0.20	6	N22	
KW 3537	XXIII.A.2.a, collared	0.71	0.48	0.42	0.22	6	N20 LL1	
KW 3586	XXIII.A.2.a, collared	0.72	0.67	0.47	0.20	6	N21 UL3	
KW 3642	XXIII.A.2.a, collared	0.62	0.64	0.48	0.15	5	N21 UR1/3	
KW 3788	XXIII.A.2.a, collared	0.71	0.59	0.47	0.18	7	O19 LR3	
KW 3973	XXIII.A.2.a, collared	0.65	0.64	0.50	0.15	7	O18 LL4	
KW 4568	XXIII.A.2.a, collared	0.79	0.69	0.52	0.21	6	N18	
KW 4858	XXIII.A.2.a, collared	0.67	0.7	0.51	0.18	7	O20 UL2	
KW 5033	XXIII.A.2.a, collared	0.87	0.58	0.64	0.27	6	M15 LL4	
Lot 7529.a	XXIII.A.2.a, collared	0.67	0.58	0.43	0.17	6	N22 UL1	Joined to Lot 7529.b
Lot 7529.b	XXIII.A.2.a, collared	0.67	0.48	0.44	0.19	6	N22 UL1	Joined to Lot 7529.a

Average diameter: 0.70 cm
Average length: 0.61 cm
Average perforation diameter: 0.19 cm
Average collar diameter: 0.48 cm
Average number of flutes: 6

Fig. B.16. Collared cogwheel faience beads. Scale 2:1.

Table B.5. Sample dimensions of grain-of-wheat variant A faience beads.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Var.	Diam.	Th.	Length	Perf. 1	Perf. 2	Location	Grooves
KW 3520	XXVI.A.3	A	0.70	0.36	1.67	0.14	0.16	N20 LL1	5 and 4
KW 3547	XXVI.A.3	A	0.72	0.39	1.68	0.13	0.15	N20 UL1	4 and 4
KW 3593	XXVI.A.3	A	0.67	0.37	1.46	0.17	0.16	N20 UL3	5 and 3
KW 3594	XXVI.A.3	A	0.69	0.40	1.79	0.12	0.17	N20 UL3	4 and 4
KW 3595	XXVI.A.3	A	0.75	0.39	1.74	0.14	0.18	N20 UL3	5 and 5
KW 3596	XXVI.A.3	A	0.66	0.44	1.43	0.24	0.16	N20 UL3	2 and 3
KW 3609	XXVI.A.3	A	0.71	0.38	1.30	0.17	0.18	O20 LL1	3 and 3
KW 3626	XXVI.A.3	A	0.69	0.39	1.75	0.16	0.15	N20 LR1	5 and 5
KW 3627	XXVI.A.3	A	0.66	0.37	1.53	0.14	0.16	N20 LR1	4 and 4
KW 3628	XXVI.A.3	A	0.66	0.41	1.66	0.13	0.17	N20 LR2	4 and 4
KW 3629	XXVI.A.3	A	0.55	0.36	1.27	0.14	0.13	N20 LR2	3 and 3
KW 3630	XXVI.A.3	A	0.64	0.38	1.59	0.15	0.18	N20 LR1	4 and 4
KW 3632	XXVI.A.3	A	0.73	0.38	1.51	0.16	0.14	O21 UR1	5 and 3
KW 3669	XXVI.A.3	A	0.64	0.36	1.22	0.19	0.17	N20 UR4	3 and 4
KW 3709	XXVI.A.3	A	0.63	0.38	1.61	0.16	0.13	N20 UR2	3 and 4
KW 3710	XXVI.A.3	A	0.67	0.35	1.67	0.15	0.15	N20 UR2	4 and 4
KW 3711	XXVI.A.3	A	0.76	0.39	1.74	0.15	0.14	N20 UR2	5 and 5
KW 3712	XXVI.A.3	A	0.70	0.41	1.74	0.15	0.16	N20 UR2	4 and 4
KW 3714	XXVI.A.3	A	0.63	0.41	1.59	0.13	0.14	N20 UR2	2 and 3
KW 3715	XXVI.A.3	A	0.84	0.47	1.92	0.20	0.18	N20 UR2	5 and 5
KW 3716	XXVI.A.3	A	0.81	0.35	1.85	0.11	0.15	N20 UR2	5 and 6
KW 3750	XXVI.A.3	A	0.56	0.33	1.52	0.13	0.13	N20 UL2	3 and 3
KW 3753	XXVI.A.3	A	0.69	0.38	1.32	0.15	0.16	O19 LL1	5 and 4
KW 3754	XXVI.A.3	A	0.65	0.38	1.66	0.13	0.15	O19 LL1	4 and 3
KW 3756	XXVI.A.3	A	0.62	0.37	1.67	0.16	0.12	O19 LL1	4 and 5
KW 3757	XXVI.A.3	A	0.63	0.42	1.56	0.15	0.14	O19 LL1	4 and 3
KW 3885	XXVI.A.3	A	0.71	0.38	1.60	0.10	0.15	N20 LR1	4 and 4
KW 3886	XXVI.A.3	A	0.67	0.37	1.44	0.11	0.15	N20 LR1	5 and 5
KW 3887	XXVI.A.3	A	0.82	0.48	1.69	0.18	0.20	N20 LR1	5 and 5
KW 3928	XXVI.A.3	A	0.75	0.45	1.32	0.20	0.16	N20 LR1	4 and 4
KW 3929	XXVI.A.3	A	0.60	0.34	1.43	0.15	0.12	N20 LR1	4 and 3
KW 3947	XXVI.A.3	A	0.72	0.40	1.51	0.13	0.15	O18 LL4	5 and 4
KW 3954	XXVI.A.3	A	0.63	0.40	1.12	0.15	0.16	N22	3 and 4
KW 3970	XXVI.A.3	A	0.74	0.47	1.73	0.18	0.18	O18 LL4	4 and 5
KW 3971	XXVI.A.3	A	0.61	0.39	1.74	0.15	0.18	O18 LL4	3 and 3
KW 3974	XXVI.A.3	A	0.69	0.35	1.43	0.14	0.15	O18 LL4	5 and 5
KW 3976	XXVI.A.3	A	0.69	0.38	1.57	0.10	0.15	O18 LL4	4 and 4
KW 4105	XXVI.A.3	A	0.63	0.37	1.68	0.14	0.15	O19 LL	4 and 4
KW 4106	XXVI.A.3	A	0.61	0.41	1.74	0.14	0.14	O19 LL	3 and 4
KW 4107	XXVI.A.3	A	0.63	0.38	1.59	0.13	0.14	O19 LL	3 and 4

Table B.5 Continued

Inv. No.	Beck No.	Var.	Diam.	Th.	Length	Perf. 1	Perf. 2	Location	Grooves
KW 4161	XXVI.A.3	A	0.75	0.38	1.67	0.15	0.16	O19 LL	4 and 5
KW 4302	XXVI.A.3	A	0.68	0.36	1.82	0.16	0.17	N20 UR	4 and 4
KW 4303	XXVI.A.3	A	0.73	0.46	1.71	0.13	0.15	N20 UR	3 AND 4
KW 4304	XXVI.A.3	A	0.59	0.36	1.58	0.09	0.12	N20 UR	3 AND 3
KW 4305	XXVI.A.3	A	0.65	0.33	1.70	0.12	0.14	N20 UR	4 and 4
KW 4306	XXVI.A.3	A	0.79	0.42	1.67	0.15	0.15	N20 UR	5 and 5
KW 4307	XXVI.A.3	A	0.66	0.36	1.64	0.12	0.14	N20 UR	4 and 4
KW 4308	XXVI.A.3	A	0.65	0.33	1.51	0.14	0.14	N20 UR	4 and 5
KW 4309	XXVI.A.3	A	0.65	0.39	1.58	0.15	0.12	N20 UR	4 and 5
KW 4317	XXVI.A.3	A	0.72	0.38	1.67	0.14	0.14	N22 LL	5 and 4
KW 4326	XXVI.A.3	A	0.82	0.45	1.67	0.15	0.16	N22 LL	5 and 5
KW 4327	XXVI.A.3	A	0.73	0.38	1.65	0.13	0.13	N22 LL	5 and 5
KW 4328	XXVI.A.3	A	0.73	0.38	1.72	0.15	0.12	N22 LL	5 and 4
KW 4329	XXVI.A.3	A	0.82	0.45	1.63	0.16	0.16	N22 LL	5 and 5
KW 4330	XXVI.A.3	A	0.65	0.41	1.44	0.15	0.15	N22 LL	3 and 4
KW 4331	XXVI.A.3	A	0.68	0.42	1.55	0.18	0.20	N22 LL	4 and 3
KW 4332	XXVI.A.3	A	0.73	0.42	1.73	0.18	0.17	N22 LL	5 and 4
KW 4456	XXVI.A.3	A	0.69	0.42	1.71	0.13	0.15	N20 LL2	4 and 3
KW 4476	XXVI.A.3	A	0.60	0.40	1.64	0.16	0.16	N20 LL2	3 and 3
KW 4559	XXVI.A.3	A	0.73	0.39	1.52	0.15	0.14	N19 UL2	5 and 4
KW 4580	XXVI.A.3	A	0.84	0.38	1.33	0.16	0.15	N19 UL4	5 and 5
KW 4783	XXVI.A.3	A	0.66	0.41	1.70	0.15	0.16	N19 UL3	3 and 4
KW 4807	XXVI.A.3	A	0.73	0.40	1.69	0.17	0.14	N19 UL3	3 and 4
KW 4808	XXVI.A.3	A	0.70	0.37	1.46	0.16	0.19	N19 UL3	4 and 4
KW 4857	XXVI.A.3	A	0.64	0.40	1.68	0.16	0.18	O20 UL2	4 and 4
KW 4996	XXVI.A.3	A	0.67	0.49	1.44	0.23	0.22	M16 LR1	2 and 3
KW 5078	XXVI.A.3	A	0.60	0.34	1.55	0.14	0.13	M19 UR4	3 and 3
KW 5079	XXVI.A.3	A	0.71	0.44	1.66	0.17	0.15	N19 UL3	4 and 4
KW 5105	XXVI.A.3	A	0.72	0.41	1.59	0.14	0.15	M19 UR3	5 and 4
KW 5129	XXVI.A.3	A	0.70	0.38	1.46	0.16	0.15	M19 UR3	5 and 4
KW 5172	XXVI.A.3	A	0.61	0.36	1.49	0.17	0.16	O18 U	4 and 4
KW 5175	XXVI.A.3	A	0.62	0.36	1.59	0.14	0.14	O19 LL3	4 and 3
KW 5259	XXVI.A.3	A	0.57	0.39	1.63	0.16	0.16	M19 UL2	3 and 3
KW 5321	XXVI.A.3	A	0.66	0.37	1.52	0.15	0.14	M18 LL4	3 and 4
KW 5451	XXVI.A.3	A	0.69	0.39	1.48	0.17	0.17	N19 UL3	4 and 5
KW 5452	XXVI.A.3	A	0.73	0.44	1.63	0.16	0.16	N19 UL3	4 and 4
KW 5453	XXVI.A.3	A	0.70	0.40	1.63	0.16	0.16	N19 UL3	3 and 3

Average diameter: 0.69 cm
Average thickness: 0.39 cm
Average length: 1.59 cm
Average perforation diameter: 0.15 cm

Table B.6. Sample dimensions of grain-of-wheat variant B faience beads.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Var.	Diam.	Th.	Length	Perf. 1	Perf. 2	Location	Grooves
KW 3633	XXVI.A.3	B	0.63	0.36	1.40	0.13	0.13	O21 UR1	2 and 2
KW 3636	XXVI.A.3	B	0.58	0.44	1.64	0.12	0.16	O18 UR2	2 and 2
KW 3829	XXVI.A.3	B	0.55	0.42	1.54	0.13	0.15	O20 UR1	2 and 2
KW 3849	XXVI.A.3	B	0.61	0.42	1.54	0.15	0.16	O21 UR2	3 and 2
KW 3937	XXVI.A.3	B	0.62	0.38	1.47	0.17	0.16	N22	2 and 2
KW 4104	XXVI.A.3	B	0.60	0.46	1.47	0.10	0.13	O19 LL	2 and 2
KW 4376	XXVI.A.3	B	0.59	0.33	1.50	0.14	0.15	N21 LR1	3 and 2
KW 4562	XXVI.A.3	B	0.66	0.43	1.57	0.15	0.16	O19 LL	2 and 2
KW 4563	XXVI.A.3	B	0.51	0.41	1.43	0.18	0.18	O19 LL	2 and 2
KW 4624	XXVI.A.3	B	0.68	0.45	1.43	0.17	0.19	N17 LR2-O17 LL2	2 and 2
KW 4625	XXVI.A.3	B	0.58	0.41	1.53	0.13	0.13	NA	2 and 2
KW 4862	XXVI.A.3	B	0.59	0.34	1.33	0.16	0.15	O20 UL3	2 and 2
KW 4888	XXVI.A.3	B	0.60	0.43	1.59	0.17	0.17	N19 UL4	2 and 2
KW 4897	XXVI.A.3	B	0.61	0.47	1.49	0.19	0.19	O19 LL4	2 and 2
KW 5027	XXVI.A.3	B	0.61	0.40	1.41	0.12	0.10	O19 LL2	2 and 2
KW 5104	XXVI.A.3	B	0.45	0.38	1.41	0.15	0.17	spoil	1 and 2
KW 5168	XXVI.A.3	B	0.63	0.40	1.47	0.15	0.20	M19 UR3	1 and 2
KW 5246	XXVI.A.3	B	0.52	0.40	1.28	0.16	0.17	M19 UR1	2 and 2
KW 5260	XXVI.A.3	B	0.59	0.43	1.33	0.18	0.16	M19 UL2	2 and 2
KW 5261	XXVI.A.3	B	0.52	0.38	1.30	0.13	0.12	M19 UL2	2 and 2
KW 5479	XXVI.A.3	B	0.62	0.33	1.36	0.14	0.09	O18 UL1	2 and 2
KW 5481	XXVI.A.3	B	0.58	0.38	1.29	0.14	0.15	O18 UL1	1 and 2

Average diameter: 0.59 cm
Average thickness: 0.40 cm
Average length: 1.44 cm
Average perforation diameter: 0.15 cm

Table B.7. Dimensions of grain-of-wheat variant C faience beads.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Var.	Diam.	Length	Perf. 1	Perf. 2	Location	Flutes
KW 4523	XXVI.A.3	C	0.59	1.65	0.15	0.17	N18	6 total
KW 5635	XXVI.A.3	C	0.53	1.72	0.19	0.19	O17 UR4	5 total

Average diameter: 0.56 cm
Average length: 1.69
Average perforation diameter: 0.18

Combined averages for all grain-of-wheat beads:

Average diameter:	0.66 cm
Average thickness:	0.40 cm
Average length:	1.56 cm
Average perforation diameter:	0.15 cm

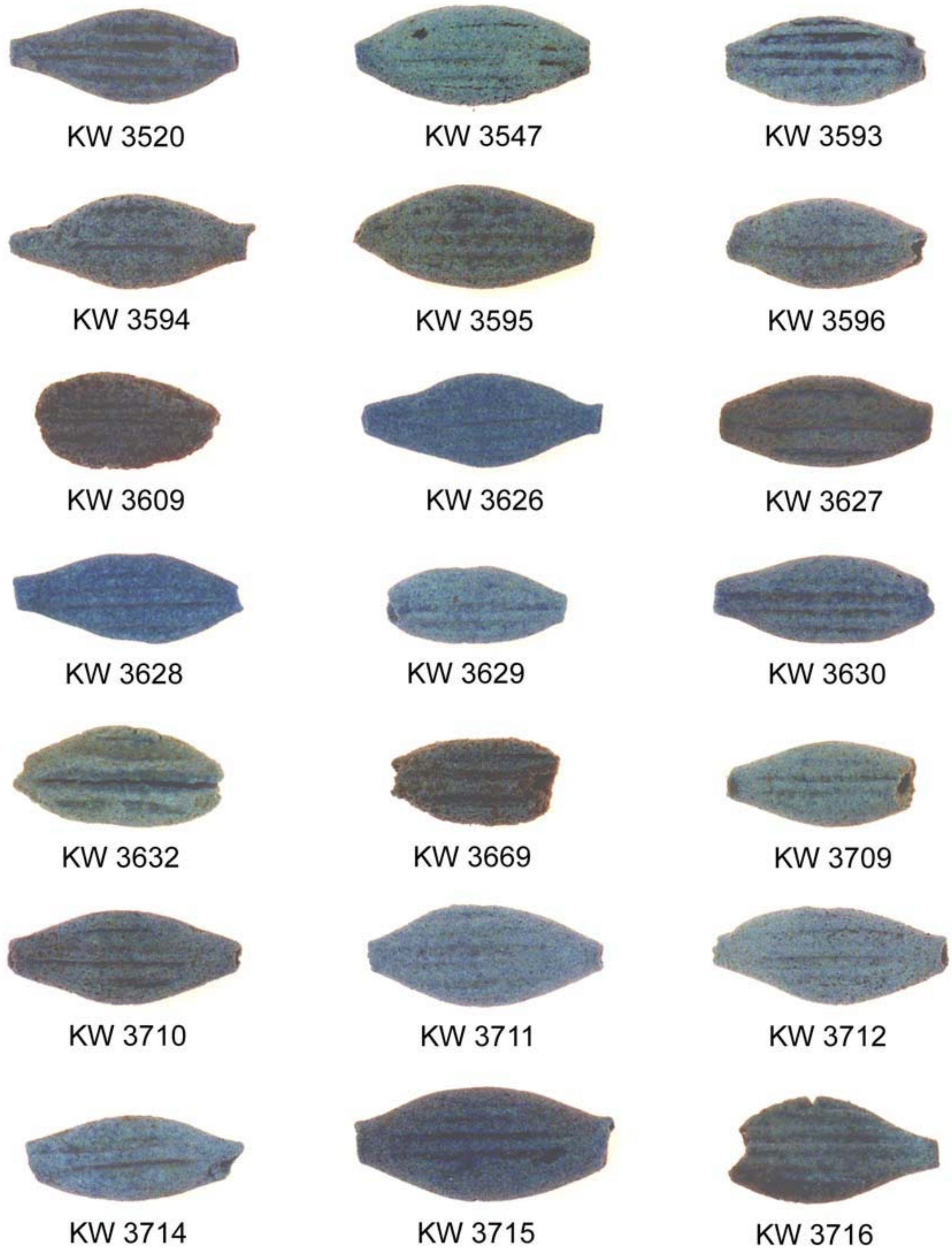

Fig. B.17. Grain-of-wheat variant A faience beads KW 3520 - KW 3716. Scale 2:1.

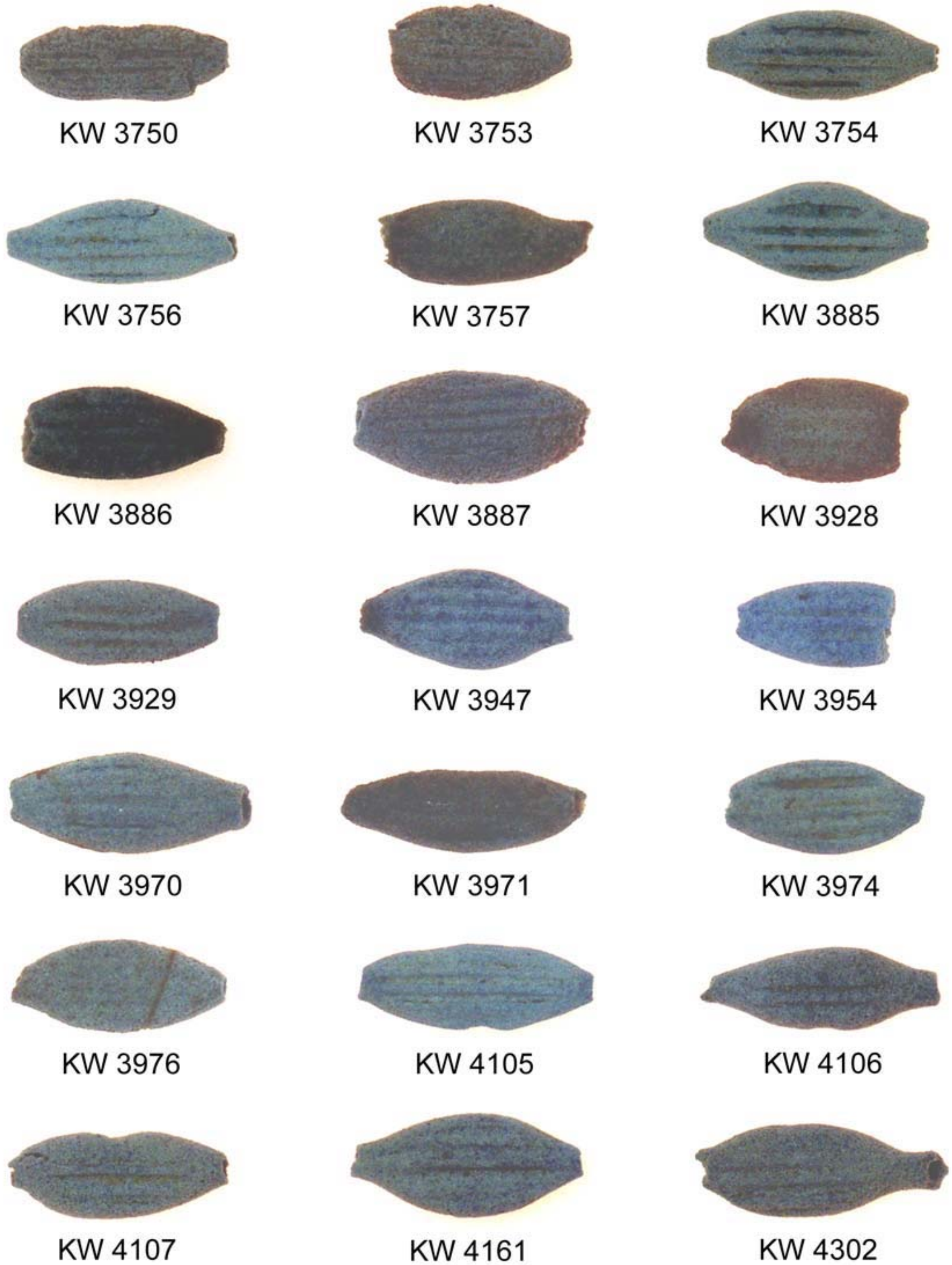

Fig. B.18. Grain-of-wheat variant A faience beads KW 3750 - KW 4302. Scale 2:1.

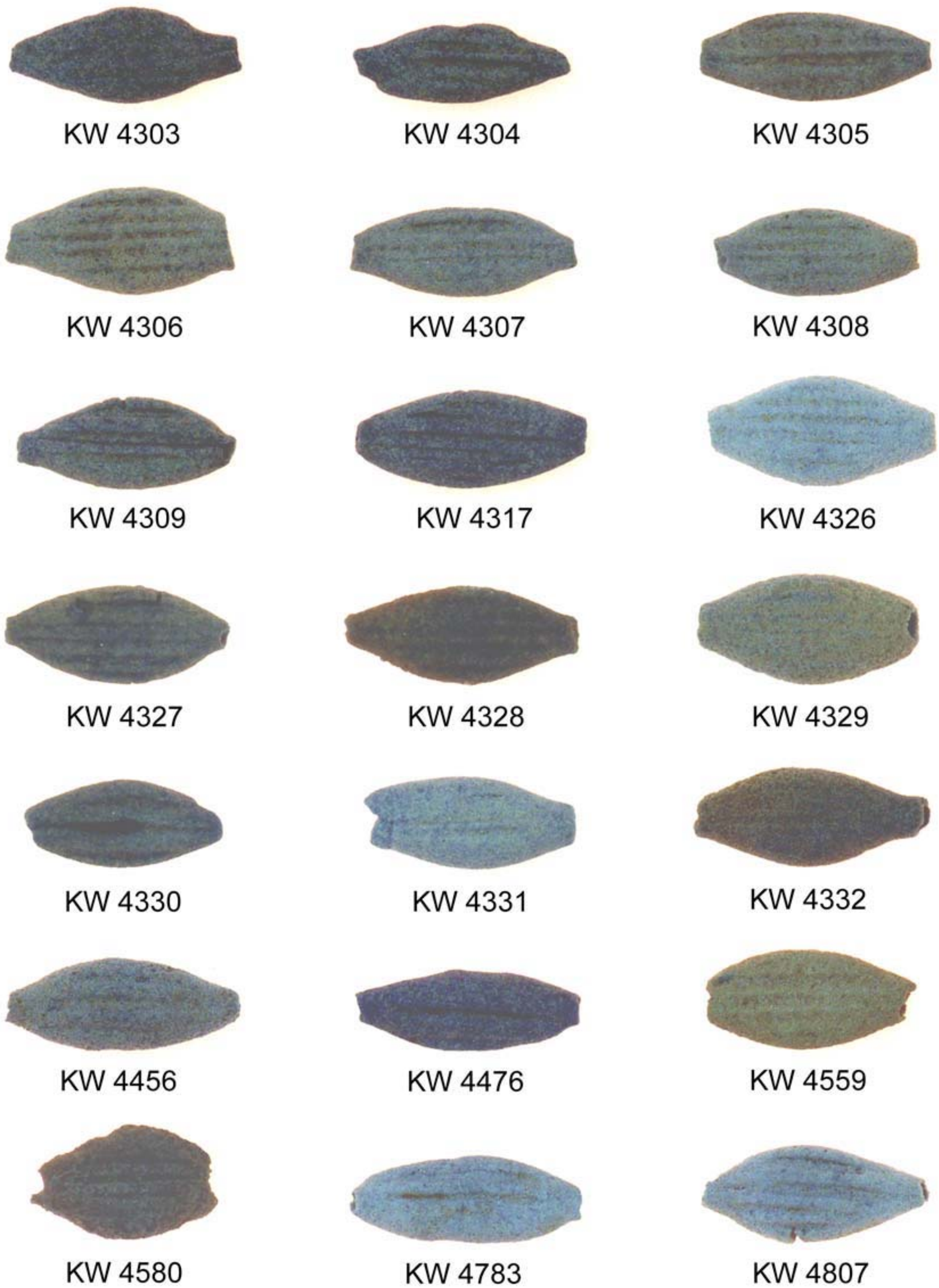

Fig. B.19. Grain-of-wheat variant A faience beads KW 4303 - KW 4807. Scale 2:1.

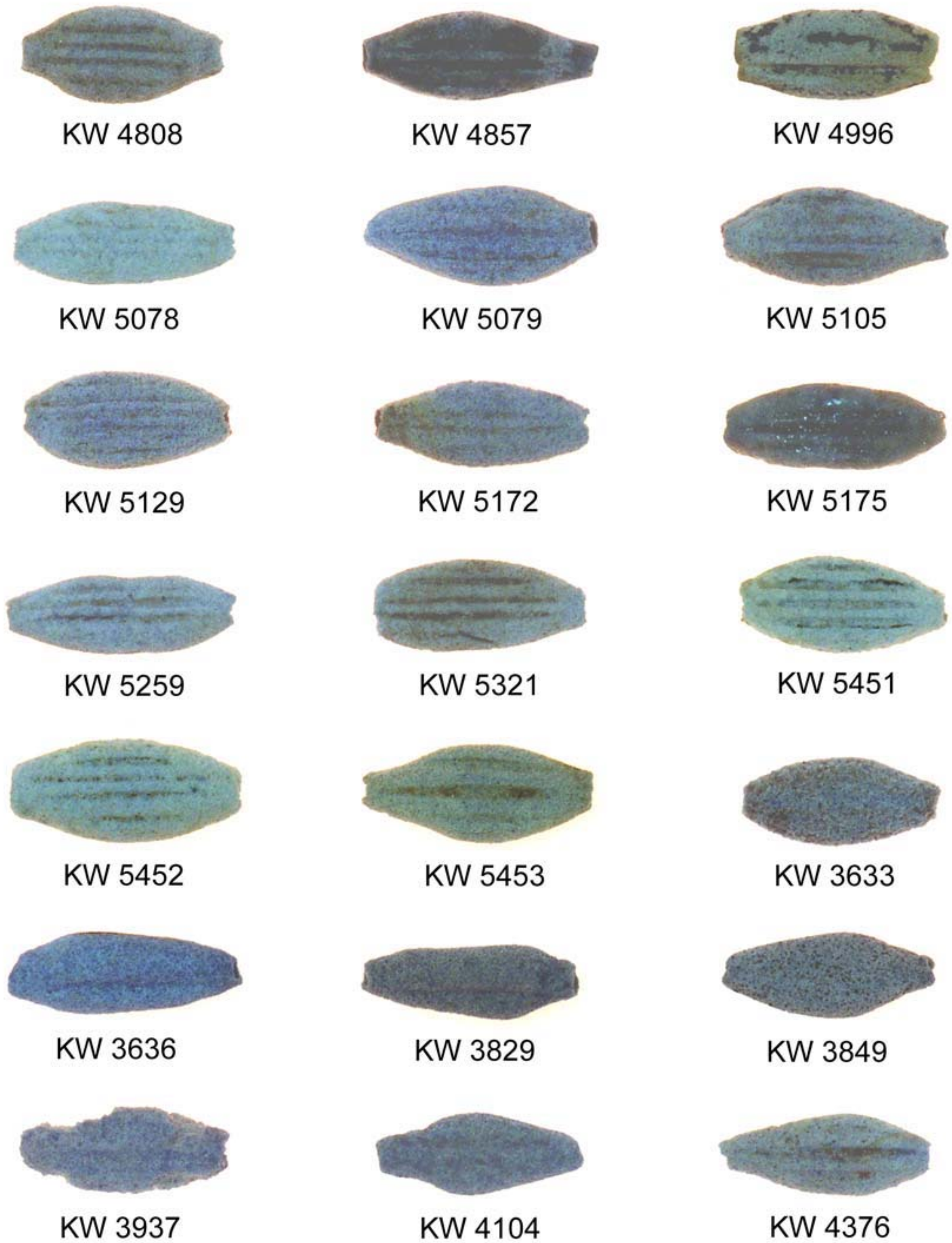

Fig. B.20. Grain-of-wheat faience beads, variant A (KW 4808 - KW 5453) and variant B (KW 3633 - KW 4376). Scale 2:1.

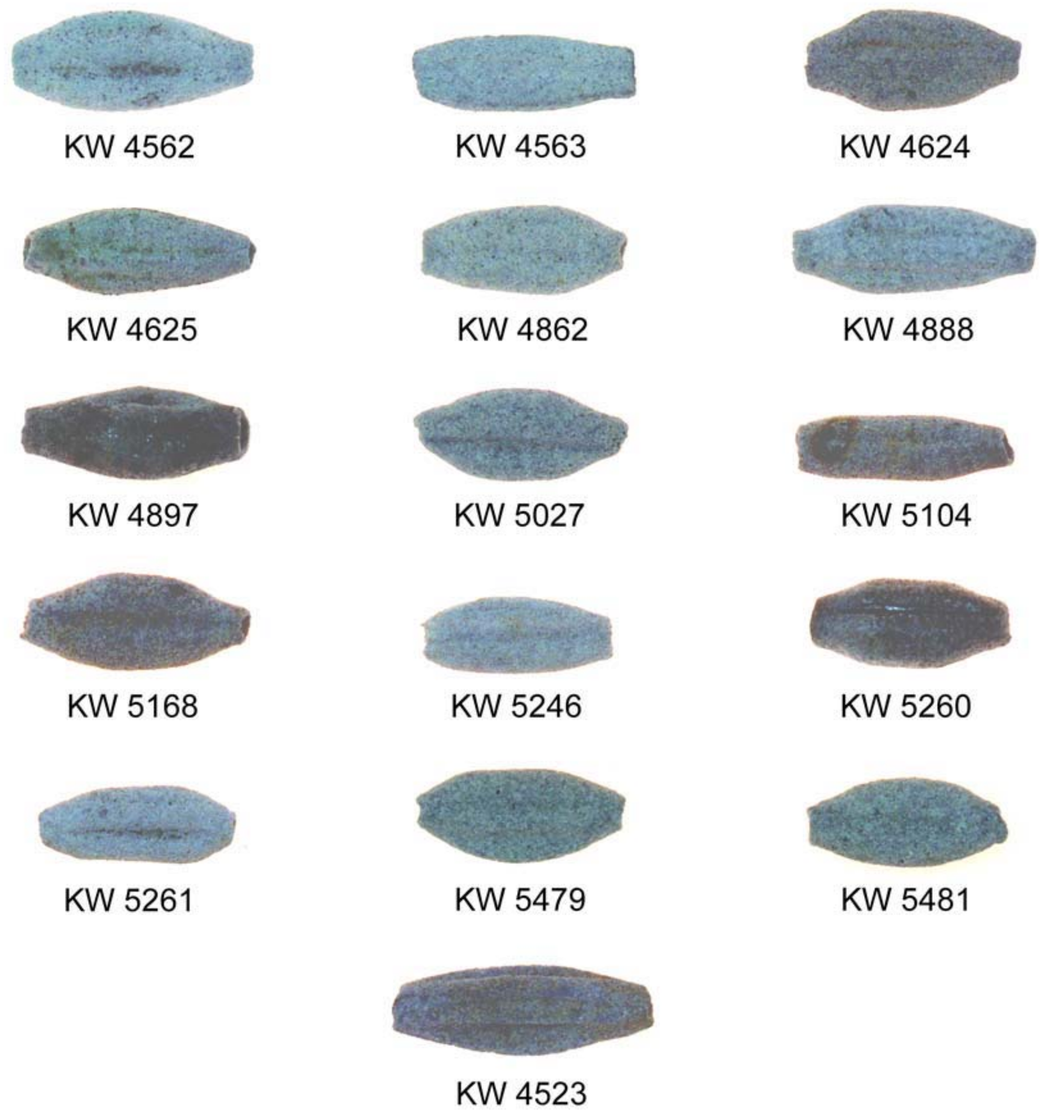

Fig. B.21. Grain-of-wheat faience beads, variant B (KW 4562 - KW 5481) and variant C. Scale 2:1.

Table B.8. Dimensions of biconical variant A faience beads.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Diam.	Length	Molded Face Perf.	Molded Face Gadroons	Incised Face Perf.	Incised Face Segments	Location
KW 32	XXIII.A.3.d	1.76	0.90	0.20	17	0.22	17	K12 LL1
KW 115	XXIII.A.3.d	1.48	0.90	0.18	17	0.23	17	K11 LL4
KW 349	XXIII.A.3.d	1.54	0.83	0.25	17	0.24	17	K14 LR3
KW 362	XXIII.A.3.d	1.48	0.77	0.23		0.24	17	L11 UR4
KW 370	XXIII.A.3.d	1.80	0.97	0.23	17	0.25	17	L11 UR4
KW 371	XXIII.A.3.d	1.42	0.84	0.22	17	0.24	17	L11 UR4
KW 384	XXIII.A.3.d	1.72	0.95	0.21	17	0.20	17	M11 UL3
KW 435	XXIII.A.3.d	1.56	0.84	0.24	17	0.24	17	J15 UL1
KW 473	XXIII.A.3.d	1.45	0.79	0.25	≥9	0.25		M12 UR4
KW 522	XXIII.A.3.d	1.89	0.93	0.22	17	0.24	17	M11 LR3
KW 569	XXIII.A.3.d	1.37	0.87	0.22		0.23	≥13	L11 UR4
KW 574	XXIII.A.3.d	1.38	0.83	0.21		0.22	≥16	L15 UL1
KW 593	XXIII.A.3.d	1.72	0.89	0.22	17	0.21	17	L11 UR4
KW 742	XXIII.A.3.d	1.66	0.83	0.23	17	0.25	17	L15 UL1
KW 811	XXIII.A.3.d	1.20	0.75	0.23	≥1	0.23		L11 LR4
KW 818	XXIII.A.3.d	1.71	0.89	0.23	17	0.22	17	K10 LL3
KW 827	XXIII.A.3.d	1.73	0.85	0.21	17	0.25	17	N12 LR3
KW 868	XXIII.A.3.d	1.85	0.96	0.22	17	0.23	17	N12 UL3
KW 902	XXIII.A.3.d	1.43	0.52	0.44		0.38	≥5	M14 LL1
KW 912	XXIII.A.3.d	1.52	0.84	0.23		0.22	≥14	M11 LL3
KW 917	XXIII.A.3.d	1.92	0.90	0.21	17	0.25	16	N12 UL4
KW 945	XXIII.A.3.d	1.66	0.92	0.28	17	0.28	17	M10 LL2
KW 964	XXIII.A.3.d	1.84	0.87	0.24	17	0.23	17	M10 LL2
KW 980	XXIII.A.3.d	1.83	0.89	0.22	17	0.21	17	M10 LL2
KW 981	XXIII.A.3.d	1.71	0.86	0.23	17	0.21	17	M10 LL1
KW 1044	XXIII.A.3.d	1.77	1.00	0.22	17	0.22	17	M10 LL1
KW 1174	XXIII.A.3.d	1.60	0.77	0.23	≥1	0.27	17	M12 UR
KW 1302	XXIII.A.3.d	1.72	0.81	0.26	17	0.25	17	M10 LL2
KW 1377	XXIII.A.3.d	1.95	0.99	0.21	17	0.22	17	M12 UL4
KW 1451	XXIII.A.3.d	1.86	0.97	0.24	17	0.25	17	M12 UL4
KW 1545	XXIII.A.3.d	1.92	0.86	0.22	17	0.23	17	L12 LL2
KW 1551	XXIII.A.3.d	1.79	0.87	0.20	≥8	0.21	17	L12 LR3
KW 1552	XXIII.A.3.d	1.64	0.89	0.24	≥15	0.23	17	L12 LL1
KW 1661	XXIII.A.3.d	1.89	1.00	0.19	17	0.21	17	M12 LL2
KW 1690	XXIII.A.3.d	1.84	0.93	0.22	17	0.22	16	L15 LL1
KW 1811	XXIII.A.3.d	1.67	0.94	0.25	17	0.25	17	L15 UR1
KW 1947	XXIII.A.3.d	1.73	0.82	0.22	17	0.22	17	N13 LL2
KW 2147	XXIII.A.3.d	1.84	0.96	0.23	17	0.23	17	N13 UL4
KW 2179	XXIII.A.3.d	1.94	0.93	0.25	17	0.28	17	N12 LL3

Table B.8 Continued

Inv. No.	Beck No.	Diam.	Length	Molded Face Perf.	Molded Face Gadroons	Incised Face Perf.	Incised Face Segments	Location
KW 2914	XXIII.A.3.d	1.69	0.95	0.25	17	0.22	17	spoil
KW 3057	XXIII.A.3.d	1.64	0.86	0.24	17	0.24	17	G19 UR3
KW 3177	XXIII.A.3.d	1.47	0.77	0.23	17	0.21	≥2	H20 LR1
KW 3252	XXIII.A.3.d	1.83	0.89	0.22	17	0.21	17	G20 LR4
KW 4750	XXIII.A.3.d	1.88	0.98	0.18	17	0.23	17	N18 UR2
KW 5213	XXIII.A.3.d	1.95	0.96	0.22	17	0.27	17	M16 UL4
KW 5234	XXIII.A.3.d	1.97	0.93	0.28	17	0.27	17	M16 UL4
KW 5525	XXIII.A.3.d	1.96	0.98	0.21	17	0.20	17	O17 LL3

Average diameter: 1.71 cm
Average length: 0.88 cm
Average perforation diameter: 0.23 cm

Table B.9. Dimensions of biconical variant B faience beads.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Diam.	Length	Perf.	Grooves	Location
KW 1595	XXIII.A.1.d	1.83	0.96	0.31	32	M12 UL3
KW 4177	XXIII.A.1.d	1.70	0.74	0.36	40	L15 UR4-LR2

Average diameter: 1.77 cm
Average length: 0.85 cm
Average perforation diameter: 0.34 cm

Table B.10. Dimensions of biconical faience beads of indeterminate variant.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Location
KW 470	I.B.1.e	1.57	0.77	0.34	0.35	J10 LR2
KW 783	I.B.1.e	1.65	0.71	0.34	0.36	L11 LR4
KW 784	I.B.1.e	1.11	0.49	0.44	0.44	M11 LL4
KW 1567	I.B.1.e	1.60	0.73	0.30	0.34	M12 LL1
KW 4366	I.B.1.e	1.85	0.75	N/A	N/A	M15 LL4

Average diameter: 1.56 cm
Average length: 0.69 cm
Average perforation diameter: 0.36 cm

Combined averages for all biconical faience beads

Average diameter:	1.69 cm
Average length:	0.86 cm
Average perforation diameter:	0.24 cm

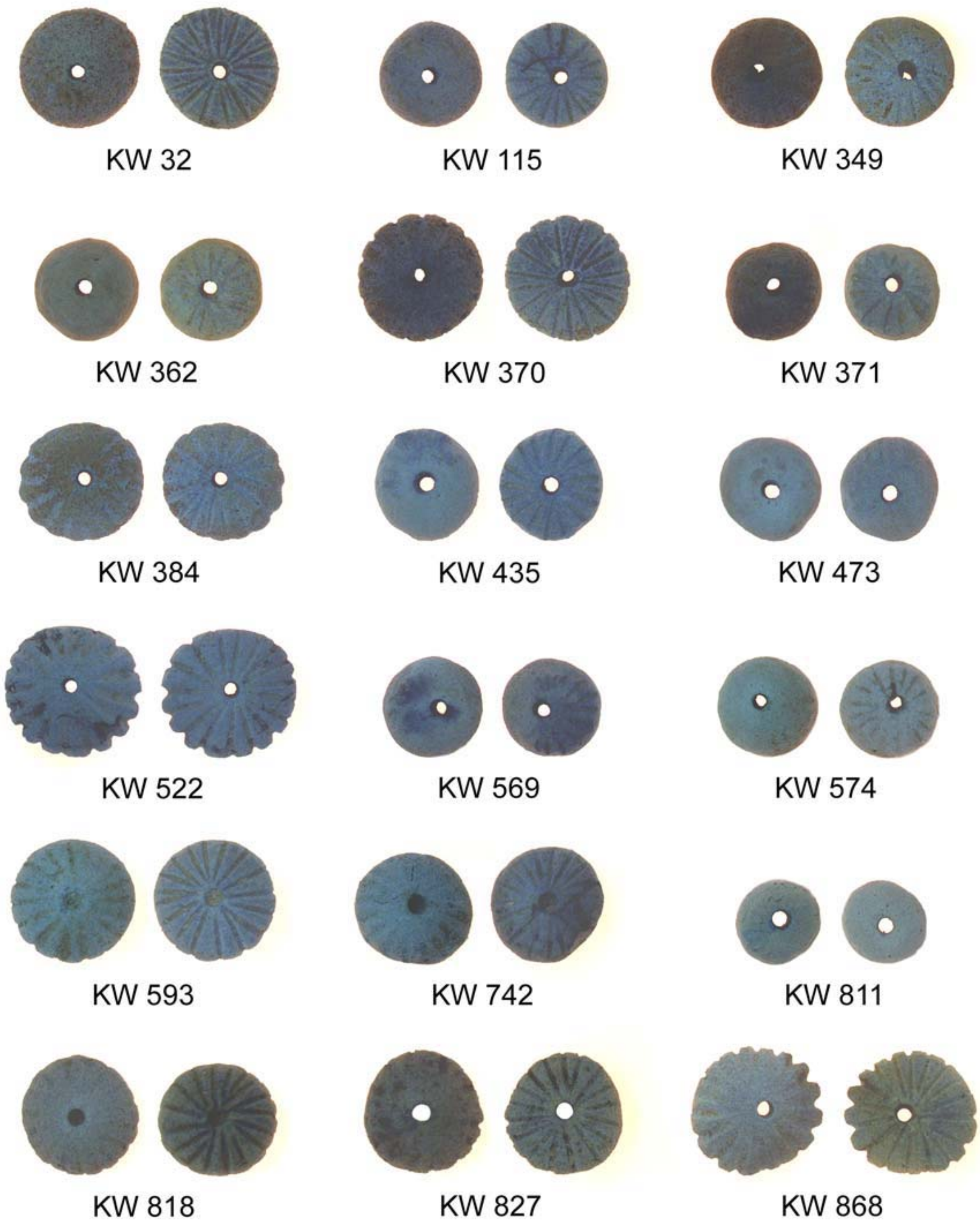

Fig. B.22. Biconical variant A faience beads KW 32 - KW 868. Scale 1:1.

Fig. B.23. Biconical variant A faience beads KW 902 - KW 1811. Scale 1:1.

Fig. B.24. Biconical faience beads, variant A (KW 1947 - KW 5525), variant B, and beads of indeterminate variant. Scale 1:1.

Table B.11. Dimensions of grooved barrel faience beads.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	End 1	End 2	Grooves	Location
KW 297	XXIII.A.1.a	0.67	1.21	0.20	0.20	0.32	0.38	13	K13 UR3
KW 478	XXIII.A.1.a	0.57	1.07	0.17	0.19	0.33	0.35	11	L11 UR4
KW 538	XXIII.A.1.a	0.65	1.07	0.16	0.17	0.4	0.38	11	M12 UR1
KW 782	XXIII.A.1.a	0.73	1.06	0.18	0.19	0.47	0.47	12	M11 LL3
KW 1496	XXIII.A.1.a	0.62	1.00	0.21	0.20	0.37	0.34	11	N13 LL4
KW 1600	XXIII.A.1.a	0.57	1.22	0.20	0.20	0.39	0.43	12	M12 UL3
KW 2029	XXIII.A.1.a	0.65	1.10	0.22	0.21	0.38	0.39	N/A	L15 LR3
KW 2151	XXIII.A.1.a	0.59	1.06	0.23	0.23	0.39	N/A	13	M13 UR2
KW 2163	XXIII.A.1.a	0.62	1.12	0.19	0.18	0.30	0.34	11	H18 UR3
KW 3445	XXIII.A.1.a	0.74	1.15	0.21	0.21	0.40	0.43	14	O17 UL2
KW 5157	XXIII.A.1.a	0.62	1.12	0.21	0.22	0.43	0.45	11	M16 UL4
KW 5459	XXIII.A.1.a	0.65	1.15	0.19	0.19	0.36	0.34	12	L16 LR2
KW 5472	XXIII.A.1.a	0.64	1.17	0.18	0.20	0.37	0.38	11	N17 UL2
KW 5603	XXIII.A.1.a	0.70	1.23	0.23	0.23	0.36	0.39	12	N17 UL2

Average diameter: 0.64 cm
Average length: 1.12 cm
Average perforation diameter: 0.20 cm
Average end diameter: 0.38 cm
Average number of grooves: 12

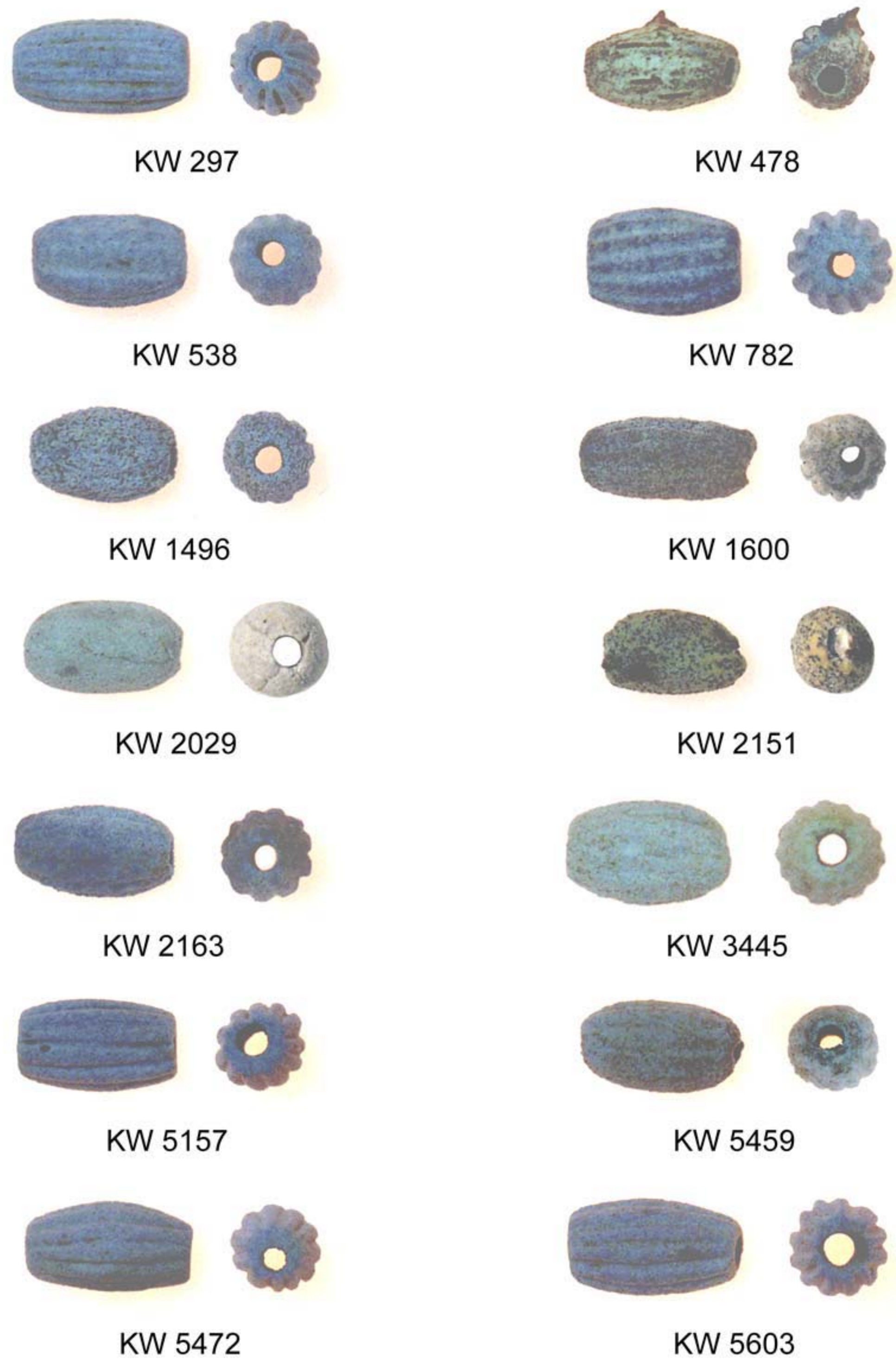

Fig. B.25. Grooved barrel faience beads. Scale 2:1.

Table B.12. Dimensions of faience button beads.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Diam.	Length	Perf.	Indent	Flutes	Location	Notes
KW 3404	XXIII.A.2.e	0.95	0.25	0.20	0.65	15	K21 LR3	Dims. from field notes
KW 3438	XXIII.A.2.e	0.90	0.30	0.20	0.55	17?	N20 LL3	Dims. from field notes
KW 3443	XXIII.A.2.e	0.98	0.28	0.24	0.63	16-17	K22 UL2	
KW 3481	XXIII.A.2.e	1.06	0.25	0.22	0.60	16?	L21 UL3	
Lot 8482	XXIII.A.2.e	0.88	0.24	0.26	N/A	N/A	K21 UR4	

Fig. B.26. Faience button and melon beads. Scale 2:1.

Table B.13. Sample dimensions of small glass beads.
All measurements are provided in centimeters.

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Location
KW 8.a	XVII.A.1.b	0.80	1.10	0.30	0.24	K12 LL
KW 8.b	I.D.1.a	0.76	1.07	0.25	0.27	K12 LL
KW 8.c	I.B.1.a	0.91	0.70	0.24	0.24	K12 LL
KW 8.d	I.B.1.a	0.76	0.66	0.22	0.22	K12 LL
KW 8.e	I.B.1.a	0.83	0.57	0.24	0.23	K12 LL
KW 8.f	I.B.1.a	0.76	0.54	0.23	0.22	K12 LL
KW 934	I.B.1.a	0.78	0.65	0.25	0.21	I15 UR4
KW 1176	I.B.1.a	0.76	0.50	0.26	0.25	L12 UR4
KW 1489.1a	XVII.A.1.b	0.81	1.20	0.31	0.29	M12 UL3
KW 1489.1b	XVII.A.1.b	0.84	1.18	0.26	0.30	M12 UL3
KW 1489.1c	I.B.1.a	0.84	0.61	0.24	0.21	M12 UL3
KW 1489.1d	I.B.1.a	0.82	0.58	0.25	0.25	M12 UL3
KW 1489.1e	I.B.1.a	0.77	0.58	0.22	0.21	M12 UL3
KW 1489.1f	I.C.1.a	0.78	0.72	0.23	0.21	M12 UL3
KW 1489.1g	I.B.1.a	0.78	0.60	0.27	0.23	M12 UL3
KW 1489.1h	I.B.1.a	0.70	0.56	0.19	0.20	M12 UL3
KW 1489.1i	I.B.1.a	0.78	0.69	0.28	0.28	M12 UL3
KW 1489.1j	I.C.1.a	0.80	0.78	0.20	0.19	M12 UL3
KW 1489.1k	I.B.1.a	0.75	0.57	0.26	0.25	M12 UL3
KW 1489.1m	I.B.1.a	0.79	0.59	0.30	0.28	M12 UL3
KW 1489.1n	I.B.1.a	0.80	0.56	0.24	0.23	M12 UL3
KW 1489.1p	I.B.1.a	0.74	0.65	0.26	0.25	M12 UL3
KW 1489.1q	I.B.1.a	0.79	0.65	0.26	0.25	M12 UL3
KW 1489.1r	I.B.1.a	0.74	0.55	0.30	0.30	M12 UL3
KW 1489.1s	I.B.1.a	0.62	0.53	0.19	0.18	M12 UL3
KW 1489.1t	I.B.1.a	0.76	0.55	0.29	0.26	M12 UL3
KW 1489.1u	I.B.1.a	0.76	0.64	0.26	0.25	M12 UL3
KW 1489.1v	I.B.1.a	0.77	0.53	0.26	0.24	M12 UL3
KW 1489.1w	XVII.A.1.b	0.66	1.18	0.15	0.13	M12 UL3
KW 1489.1x	I.C.1.a	0.71	0.65	0.21	0.19	M12 UL3
KW 1489.1y	I.B.1.a	0.83	0.66	0.23	0.23	M12 UL3
KW 1489.1z	I.C.1.a	0.84	0.80	0.21	0.21	M12 UL3
KW 1489.2a	I.B.1.a	0.74	0.61	0.22	0.12	M12 UL3
KW 1489.2b	I.B.1.a	0.83	0.60	0.29	0.29	M12 UL3
KW 1489.2c	I.B.1.a	0.80	0.61	0.25	0.22	M12 UL3
KW 1489.2d	XVII.A.1.b	0.76	1.33	0.24	0.24	M12 UL3
KW 1489.2e	I.B.1.a	0.71	0.54	0.24	0.24	M12 UL3
KW 1489.2f	I.B.1.a	0.78	0.68	0.21	0.18	M12 UL3
KW 1489.2g	I.B.1.a	0.78	0.58	0.25	0.25	M12 UL3
KW 1489.2h	I.B.1.a	0.78	0.58	0.30	0.28	M12 UL3

Table B.13 Continued

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Location
KW 1489.2i	I.B.1.a	0.78	0.60	0.23	0.23	M12 UL3
KW 1489.2j	I.B.1.a	0.81	0.54	0.23	0.21	M12 UL3
KW 1489.2k	I.B.1.a	0.70	0.60	0.24	0.20	M12 UL3
KW 1489.2m	I.B.1.a	0.70	0.60	0.18	0.15	M12 UL3
KW 1489.2n	I.B.1.a	0.71	0.61	0.25	0.21	M12 UL3
KW 1489.2p	I.B.1.a	0.70	0.55	0.26	0.24	M12 UL3
KW 1489.2q	I.B.1.a	0.80	0.65	0.24	0.22	M12 UL3
KW 1489.2r	I.B.1.a	0.74	0.64	0.23	0.20	M12 UL3
KW 1489.2s	I.B.1.a	0.71	0.57	0.20	0.19	M12 UL3
KW 1489.2t	I.B.1.a	0.71	0.47	0.27	0.27	M12 UL3
KW 1489.2u	I.B.1.a	0.82	0.54	0.25	0.22	M12 UL3
KW 1489.2v	I.B.1.a	0.73	0.60	0.22	0.19	M12 UL3
KW 1489.2w	I.B.1.a	0.70	0.54	0.22	0.21	M12 UL3
KW 1489.2x	I.C.1.a	0.70	0.66	0.18	0.09	M12 UL3
KW 1489.2y	I.B.1.a	0.74	0.53	0.28	0.28	M12 UL3
KW 1489.2z	I.C.1.a	0.74	0.67	0.18	0.18	M12 UL3
KW 1489.3a	I.B.1.a	0.76	0.56	0.25	0.24	M12 UL3
KW 1489.3b	I.B.1.a	0.78	0.48	0.26	0.26	M12 UL3
KW 1489.3c	I.B.1.a	0.76	0.60	0.25	0.24	M12 UL3
KW 1489.3d	I.B.1.a	0.73	0.62	0.20	0.19	M12 UL3
KW 1489.3e	I.B.1.a	0.76	0.49	0.22	0.22	M12 UL3
KW 1489.3f	I.B.1.a	0.77	0.60	0.28	0.27	M12 UL3
KW 1489.3g	I.B.1.a	0.81	0.62	0.21	0.21	M12 UL3
KW 1489.3h	I.B.1.a	0.72	0.63	0.20	0.20	M12 UL3
KW 1489.3i	I.B.1.a	0.72	0.52	0.19	0.19	M12 UL3
KW 1489.3j	I.B.1.a	0.77	0.60	0.26	0.24	M12 UL3
KW 1489.3k	I.C.1.a	0.73	0.66	0.18	0.18	M12 UL3
KW 1489.3m	I.B.1.a	0.72	0.62	0.22	0.22	M12 UL3
KW 1489.3n	I.B.1.a	0.76	0.65	0.20	0.18	M12 UL3
KW 1489.3p	I.B.1.a	0.83	0.64	0.24	0.23	M12 UL3
KW 1489.3q	I.C.1.a	0.66	0.60	0.16	No perf.	M12 UL3
KW 1489.3r	I.B.1.a	0.75	0.65	0.22	0.21	M12 UL3
KW 1489.3s	I.B.1.a	0.74	0.59	0.25	0.24	M12 UL3
KW 1489.3t	I.C.1.a	0.74	0.75	0.19	0.19	M12 UL3
KW 1489.3u	I.B.1.a	0.75	0.61	0.21	0.19	M12 UL3
KW 1489.3v	I.B.1.a	0.71	0.50	0.23	0.22	M12 UL3
KW 1489.3w	I.B.1.a	0.69	0.57	0.26	0.26	M12 UL3
KW 1489.3x	I.B.1.a	0.71	0.54	0.20	0.20	M12 UL3
KW 1489.3y	I.B.1.a	0.72	0.52	0.22	0.19	M12 UL3
KW 1489.3z	I.B.1.a	0.70	0.48	0.18	0.16	M12 UL3
KW 1489.4a	I.B.1.a	0.78	0.62	0.24	0.24	M12 UL3
KW 1489.4b	I.B.1.a	0.69	0.53	0.17	0.17	M12 UL3

Table B.13 Continued

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Location
KW 1489.4c	XVII.A.1.b	0.77	1.10	0.22	N/A	M12 UL3
KW 1489.4d	I.B.1.a	0.76	0.54	0.23	N/A	M12 UL3
KW 1489.4e	I.B.1.a	0.82	0.58	0.25	0.24	M12 UL3
KW 1489.4f	I.B.1.a	0.84	0.60	0.32	0.29	M12 UL3
KW 1489.4g	I.B.1.a	0.79	0.61	0.26	0.25	M12 UL3
KW 1489.4h	I.B.1.a	0.81	0.63	0.26	0.26	M12 UL3
KW 1489.4i	I.B.1.a	0.83	0.60	0.27	0.25	M12 UL3
KW 1489.4j	I.B.1.a	0.72	0.52	0.21	N/A	M12 UL3
KW 1550.a	I.B.1.a	0.90	0.69	0.29	0.27	L12 LR3
KW 1550.b	I.B.1.a	0.79	0.63	0.24	0.23	L12 LR3
KW 1777	I.B.1.a	0.83	0.63	0.28	0.27	K16 UR1
KW 1911.a	I.B.1.a	0.82	0.56	0.30	0.30	L12 LR1-3
KW 1911.b	I.B.1.a	0.70	0.62	0.26	0.25	L12 LR1-3
KW 1911.c	I.B.1.a	0.78	0.56	0.23	0.22	L12 LR1-3
KW 1911.d	I.B.1.a	0.77	0.60	0.20	0.20	L12 LR1-3
Lot 10316.a	I.B.1.a	0.89	0.61	0.29	0.27	N16 LL
Lot 10316.b	I.B.1.a	0.82	0.53	0.25	0.23	N16 LL
Lot 10316.c	I.B.1.a	0.76	0.54	0.27	0.25	N16 LL

Average diameter:	0.76 cm
Average length:	0.60 cm (excludes segmented bead lengths)
Average perforation diameter:	0.23 cm

Fig. B.27. Small glass beads KW 8.a - KW 1489.1h. Scale 2:1.

Fig. B.28. Small glass beads KW 1489.1i - KW 1489.2b. Scale 2:1.

Fig. B.29. Small glass beads KW 1489.2c - KW 1489.2v. Scale 2:1.

Fig. B.30. Small glass beads KW 1489.2w - KW 1489.3p. Scale 2:1.

Fig. B.31. Small glass beads KW 1489.3q - KW 1489.4h. Scale 2:1.

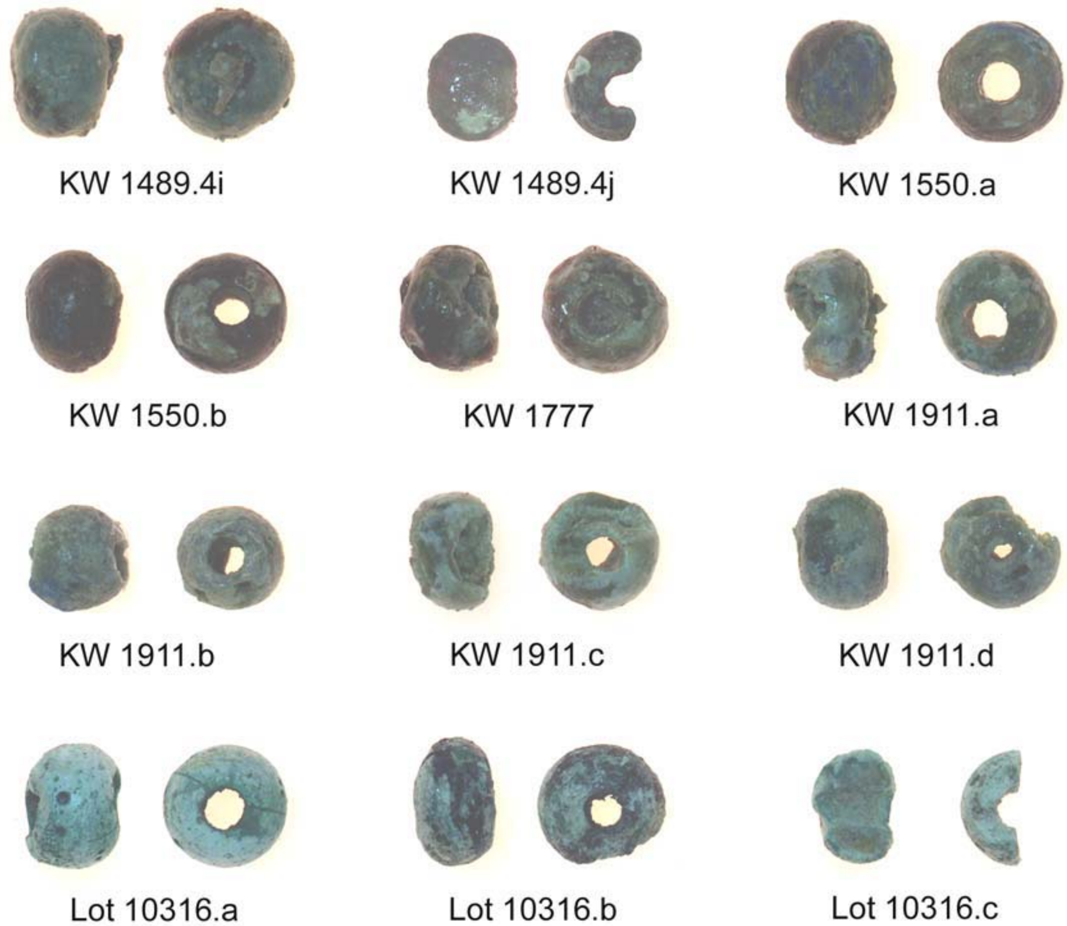

Fig. B.32. Small glass beads KW 1489.4i - Lot 10316.c. Scale 2:1.

Table B.14. Sample dimensions of large glass beads.
All measurements are provided in centimeters

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Location	Decoration
KW 1487	I.B.1.a	1.25	1.00	0.33	0.20	L16 UL4	
KW 1695	I.B.1.a	1.33	0.90	0.36	0.35	L15 UR3	Spot
KW 1948	I.B.1.a	1.11	0.79	0.35	0.32	L14 LL4	Spot
KW 2330	I.B.1.a	1.39	0.84	0.50	0.48	N23 UL2	
KW 2502	I.B.1.a	1.16	0.79	0.41	0.41	N23 UL3	Crumb
KW 2673	I.B.1.a	1.25	0.78	0.38	0.35	L20 UL2	Crumb
KW 2674	I.B.1.a	1.03	0.87	0.28	0.25	L20 UL2	
KW 2702	I.B.1.a	1.36	0.79	0.45	0.45	N23 UL3	
KW 2706	I.B.1.a	1.21	0.86	0.37	0.36	N22 UR3	
KW 2787	I.B.1.a	1.25	0.80	0.37	0.34	O21 UR1	Spot
KW 3007	I.B.1.a	1.15	0.70	0.37	0.34	M19 UR4	Crumb
Lot 7100	I.B.1.a	1.05	0.72	0.34	0.33	N18	
Lot 7621	I.B.1.a	1.27	0.95	0.38	0.35	N18 UR3	
Lot 7688	I.B.1.a	1.27	0.78	0.37	0.33	N22 LR4	
Lot 7832	I.B.1.a	1.30	0.92	0.51	0.49	N21 LR4	
Lot 9845	I.B.1.a	1.28	0.90	0.42	0.44	M17 UR2	Spot
Lot 9855.1a	I.B.1.a	1.49	1.15	0.40	No perf.	P18 UL	Spot
Lot 9855.1b	I.B.1.a	1.19	0.75	0.35	0.31	P18 UL	Crumb
Lot 9855.1c	I.B.1.a	1.20	0.81	0.41	0.40	P18 UL	Spot and crumb
Lot 9855.1d	I.B.1.a	1.43	0.82	0.52	0.52	P18 UL	Spot
Lot 9855.1e	I.B.1.a	1.33	0.93	0.47	0.43	P18 UL	Spot
Lot 9855.1f	I.B.1.a	1.12	0.58	0.41	0.40	P18 UL	
Lot 9855.1g	I.B.1.a	1.31	0.85	0.47	0.45	P18 UL	Crumb
Lot 9855.1h	I.B.1.a	1.11	0.66	0.43	0.41	P18 UL	Crumb
Lot 9855.1i	I.B.1.a	1.30	0.84	0.40	0.45	P18 UL	
Lot 9855.1j	I.B.1.a	1.22	0.71	0.44	0.42	P18 UL	
Lot 9855.1k	I.B.1.a	1.44	1.05	0.38	0.37	P18 UL	
Lot 9855.1m	I.B.1.a	1.15	0.69	0.34	0.36	P18 UL	Spot and crumb
Lot 9855.1n	I.B.1.a	1.36	0.91	0.38	0.34	P18 UL	Crumb
Lot 9855.1p	I.B.1.a	1.39	0.94	0.41	0.35	P18 UL	Crumb
Lot 9855.1q	I.B.1.a	1.36	0.87	0.47	0.45	P18 UL	Spot
Lot 9855.1r	I.B.1.a	1.23	0.83	0.38	0.39	P18 UL	
Lot 9855.1s	I.B.1.a	1.23	0.80	0.41	0.37	P18 UL	Crumb
Lot 9855.1t	I.B.1.a	1.23	0.85	0.38	0.37	P18 UL	Crumb
Lot 9855.1u	I.B.1.a	1.29	0.85	0.45	0.44	P18 UL	Spot
Lot 9855.1v	I.B.1.a	1.30	0.75	0.55	0.55	P18 UL	
Lot 9855.1w	I.B.1.a	1.28	0.98	0.38	0.37	P18 UL	Spot
Lot 9855.1x	I.B.1.a	1.39	0.92	0.50	0.48	P18 UL	Spot
Lot 9855.1y	I.B.1.a	1.36	0.75	0.50	0.45	P18 UL	Crumb
Lot 9855.1z	I.B.1.a	1.18	0.73	0.38	0.43	P18 UL	

Table B.14 Continued

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Location	Decoration
Lot 9855.2a	I.B.1.a	1.27	0.79	0.40	0.41	P18 UL	Crumb
Lot 9855.2b	I.B.1.a	1.20	0.99	0.33	0.28	P18 UL	Spot and crumb
Lot 9855.2c	I.B.1.a	1.22	0.78	0.34	0.40	P18 UL	Spot and crumb
Lot 9855.2d	I.B.1.a	1.24	0.86	0.38	0.37	P18 UL	Crumb
Lot 9855.2e	I.B.1.a	1.48	1.01	0.46	0.47	P18 UL	Spot and crumb
Lot 9855.2f	I.B.1.a	1.10	0.63	0.42	0.40	P18 UL	Crumb
Lot 9855.2g	I.B.1.a	1.19	0.75	0.40	0.37	P18 UL	Spot and crumb
Lot 9855.2h	I.B.1.a	1.32	0.93	0.51	0.50	P18 UL	
Lot 9855.2i	I.B.1.a	1.32	0.75	0.41	0.41	P18 UL	
Lot 9855.2j	I.B.1.a	1.14	0.74	0.32	0.31	P18 UL	Spot and crumb
Lot 9855.2k	I.B.1.a	1.30	0.83	0.33	0.29	P18 UL	Spot
Lot 9855.2m	I.B.1.a	1.12	0.77	0.46	0.45	P18 UL	Spot
Lot 9855.2n	I.B.1.a	1.18	0.75	0.32	0.31	P18 UL	Spot
Lot 9855.2p	I.B.1.a	1.21	0.80	0.46	0.44	P18 UL	
Lot 9855.2q	I.B.1.a	1.24	0.74	0.52	0.49	P18 UL	Crumb
Lot 9855.2r	I.B.1.a	1.18	0.86	0.31	0.31	P18 UL	Crumb
Lot 9855.2s	I.B.1.a	1.25	1.06	0.31	0.31	P18 UL	Spot
Lot 9855.2t	I.B.1.a	1.21	0.71	0.31	0.28	P18 UL	Spot
Lot 9855.2u	I.B.1.a	1.20	0.81	0.34	0.34	P18 UL	Spot
Lot 9855.2v	I.B.1.a	1.31	0.92	0.35	0.31	P18 UL	Spot
Lot 9855.2w	I.B.1.a	1.35	0.85	0.65	0.64	P18 UL	
Lot 9855.2x	I.B.1.a	1.45	0.82	0.56	0.54	P18 UL	Spot
Lot 9855.2y	I.B.1.a	1.10	0.64	0.46	0.44	P18 UL	Spot
Lot 9855.2z	I.B.1.a	1.25	0.95	0.34	0.30	P18 UL	
Lot 9855.3a	I.B.1.a	1.12	0.68	0.46	0.44	P18 UL	
Lot 9855.3b	I.B.1.a	1.16	0.78	0.40	0.39	P18 UL	Spot
Lot 9855.3c	I.B.1.a	1.18	0.69	0.48	0.47	P18 UL	Spot
Lot 9855.3d	I.B.1.a	1.01	0.68	0.46	0.44	P18 UL	
Lot 9855.3e	I.B.1.a	1.10	0.76	0.40	0.38	P18 UL	
Lot 9855.3f	I.B.1.a	1.33	0.81	0.46	0.44	P18 UL	Crumb
Lot 9855.3g	I.B.1.a	1.22	0.68	0.40	0.39	P18 UL	
Lot 9855.3h	I.B.1.a	1.24	0.87	0.41	0.42	P18 UL	
Lot 9855.3i	I.B.1.a	1.22	0.80	0.40	0.38	P18 UL	
Lot 9855.3j	I.B.1.a	1.29	0.79	0.49	0.49	P18 UL	
Lot 9855.3k	I.B.1.a	1.16	0.77	0.42	0.41	P18 UL	
Lot 9855.3m	I.B.1.a	1.49	1.10	0.41	0.41	P18 UL	
Lot 9855.3n	I.B.1.a	1.24	0.87	0.32	0.29	P18 UL	Spot
Lot 9855.3p	I.B.1.a	1.29	0.83	0.40	0.38	P18 UL	Spot
Lot 9855.3q	I.B.1.a	1.13	0.78	0.41	0.38	P18 UL	
Lot 9855.3r	I.B.1.a	1.42	0.80	0.49	0.49	P18 UL	
Lot 9855.3s	I.B.1.a	1.25	0.73	0.43	0.45	P18 UL	Spot
Lot 9855.3t	I.B.1.a	1.24	0.75	0.41	0.39	P18 UL	

Table B.14 Continued

Inv. No.	Beck No.	Diam.	Length	Perf. 1	Perf. 2	Location	Decoration
Lot 9855.3u	I.B.1.a	1.30	0.86	0.48	0.45	P18 UL	Spot
Lot 9855.3v	I.B.1.a	1.20	0.98	0.33	0.32	P18 UL	
Lot 9855.3w	I.B.1.a	1.19	0.67	0.40	0.36	P18 UL	
Lot 9855.3x	I.B.1.a	1.12	0.93	0.36	0.33	P18 UL	Spot
Lot 9855.3y	I.B.1.a	1.20	0.93	0.40	0.34	P18 UL	
Lot 9855.3z	I.B.1.a	1.32	0.74	0.36	N/A	P18 UL	Crumb
Lot 9855.4a	I.B.1.a	1.21	0.82	0.39	0.35	P18 UL	Spot
Lot 9855.4b	I.B.1.a	1.38	0.82	0.53	0.53	P18 UL	
Lot 9855.4c	I.B.1.a	1.28	0.82	0.34	0.35	P18 UL	
Lot 9855.4d	I.B.1.a	1.31	0.74	0.43	0.42	P18 UL	Spot
Lot 9855.4e	I.B.1.a	1.48	0.91	0.49	0.48	P18 UL	Spot and crumb
Lot 9855.4f	I.B.1.a	1.22	0.73	0.36	0.35	P18 UL	Spot
Lot 9855.4g	I.B.1.a	1.27	1.04	0.34	0.34	P18 UL	Spot
Lot 9855.4h	I.B.1.a	1.30	1.02	0.33	0.32	P18 UL	Spot
Lot 9855.4i	I.B.1.a	1.44	0.89	0.47	0.47	P18 UL	Spot
Lot 9855.4j	I.B.1.a	1.29	0.83	0.38	0.36	P18 UL	Crumb
Lot 9855.4k	I.B.1.a	1.30	0.92	0.37	0.36	P18 UL	Spot and crumb
Lot 10208	I.B.1.a	1.18	0.69	0.38	0.34	N17 UL	Spot

Average diameter: 1.25 cm
Average length: 0.83 cm
Average perforation diameter: 0.40 cm

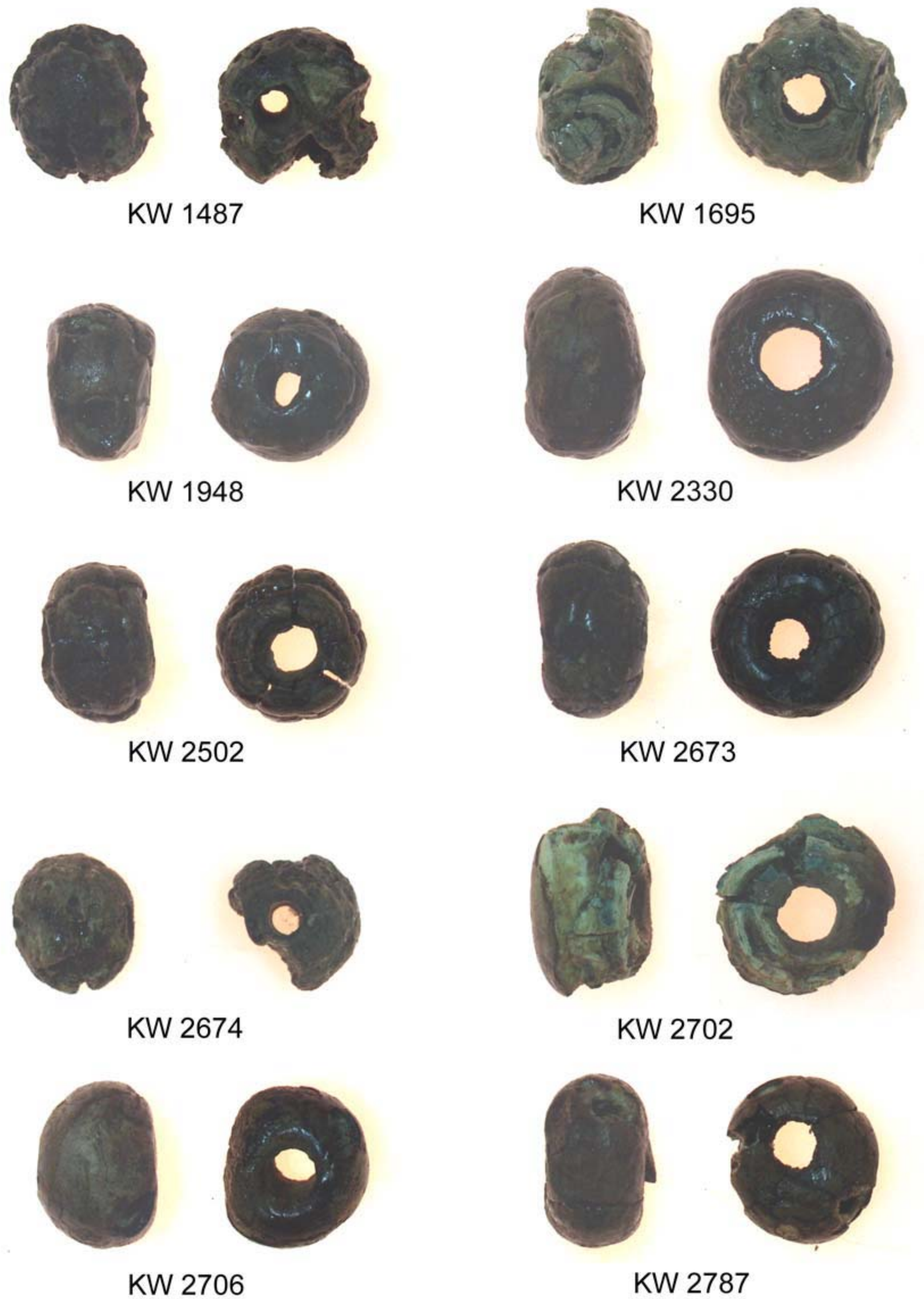

Fig. B.33. Large glass beads KW 1487 - KW 2787. Scale 2:1.

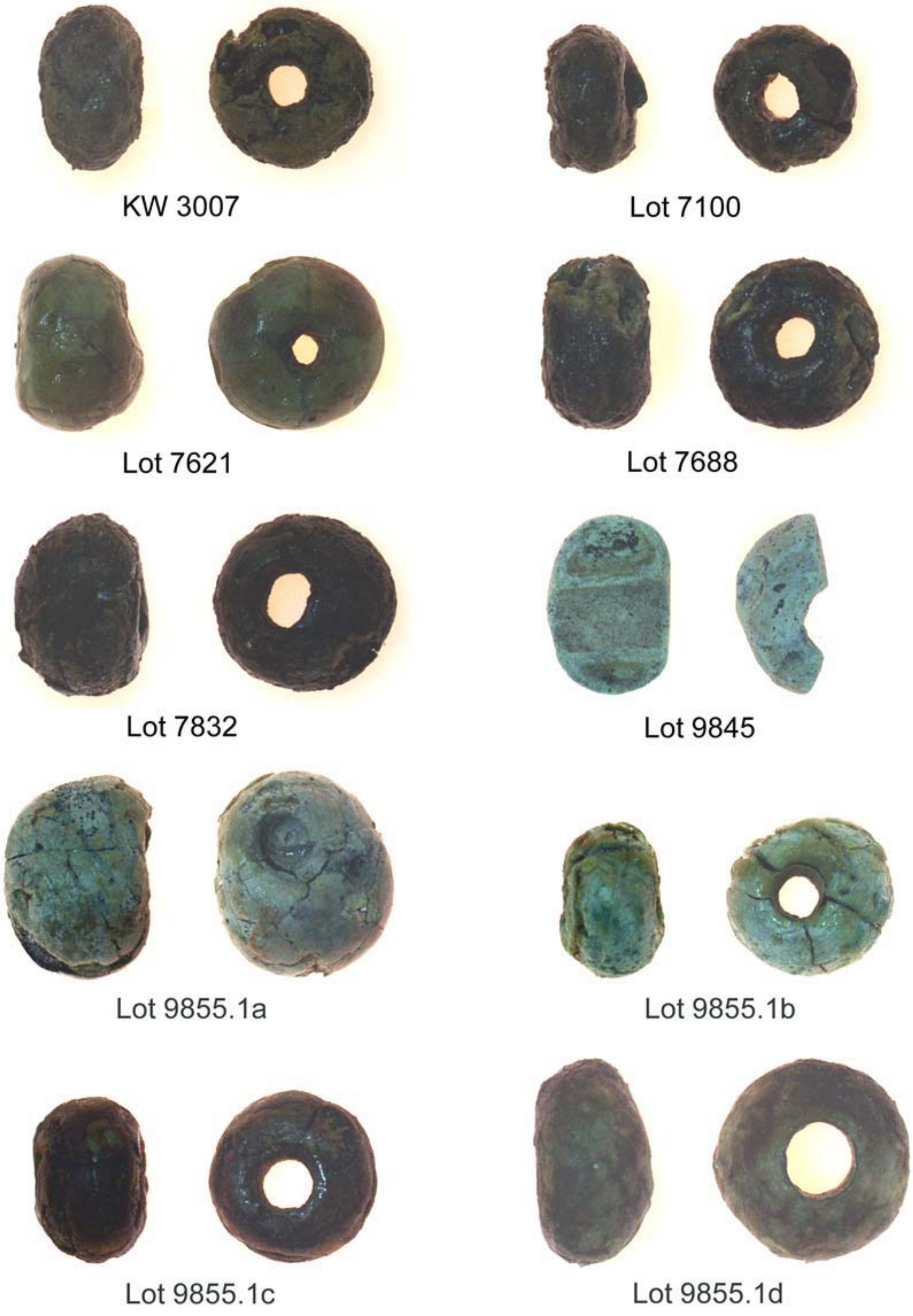

Fig. B.34. Large glass beads KW 3007 - Lot 9855.1d. Scale 2:1.

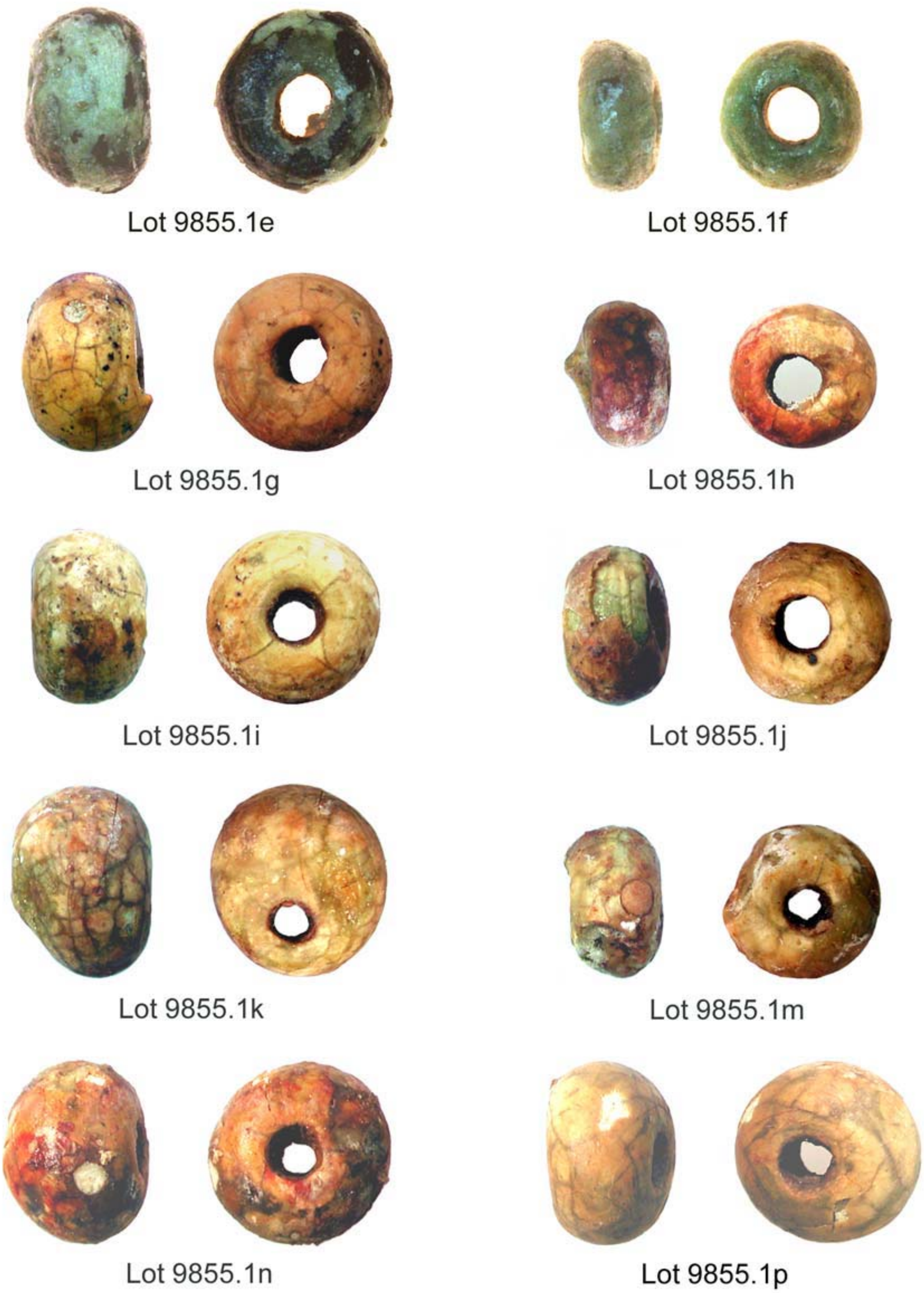

Fig. B.35. Large glass beads Lot 9855.1e - Lot 9855.1p. Scale 2:1.

Fig. B.36. Large glass beads Lot 9855.1q - Lot 9855.1z. Scale 2:1.

Fig. B.37. Large glass beads Lot 9855.2a - Lot 9855.2j. Scale 2:1.

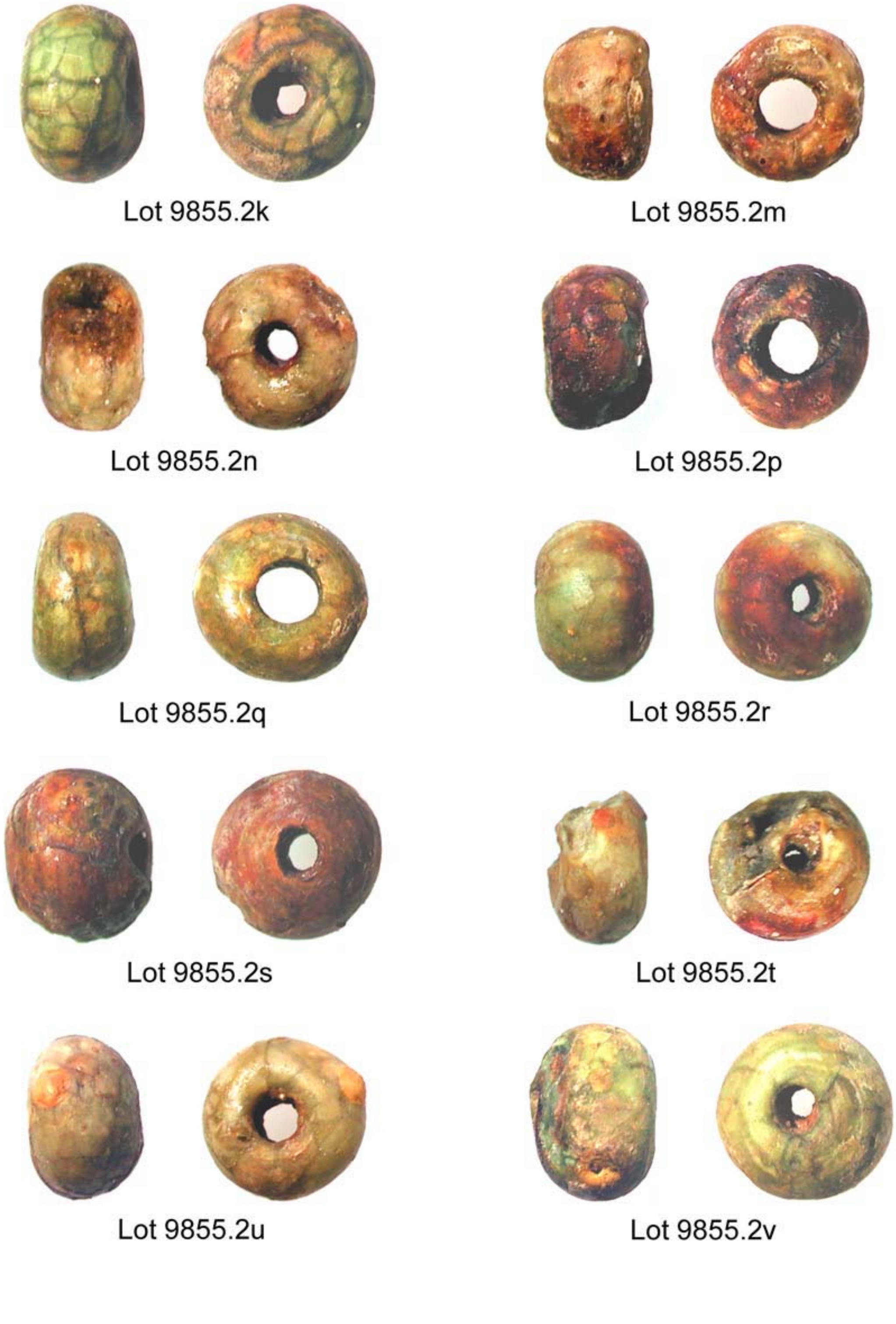

Fig. B.38. Large glass beads Lot 9855.2k - Lot 9855.2v. Scale 2:1.

Fig. B.39. Large glass beads Lot 9855.2w - Lot 9855.3f. Scale 2:1.

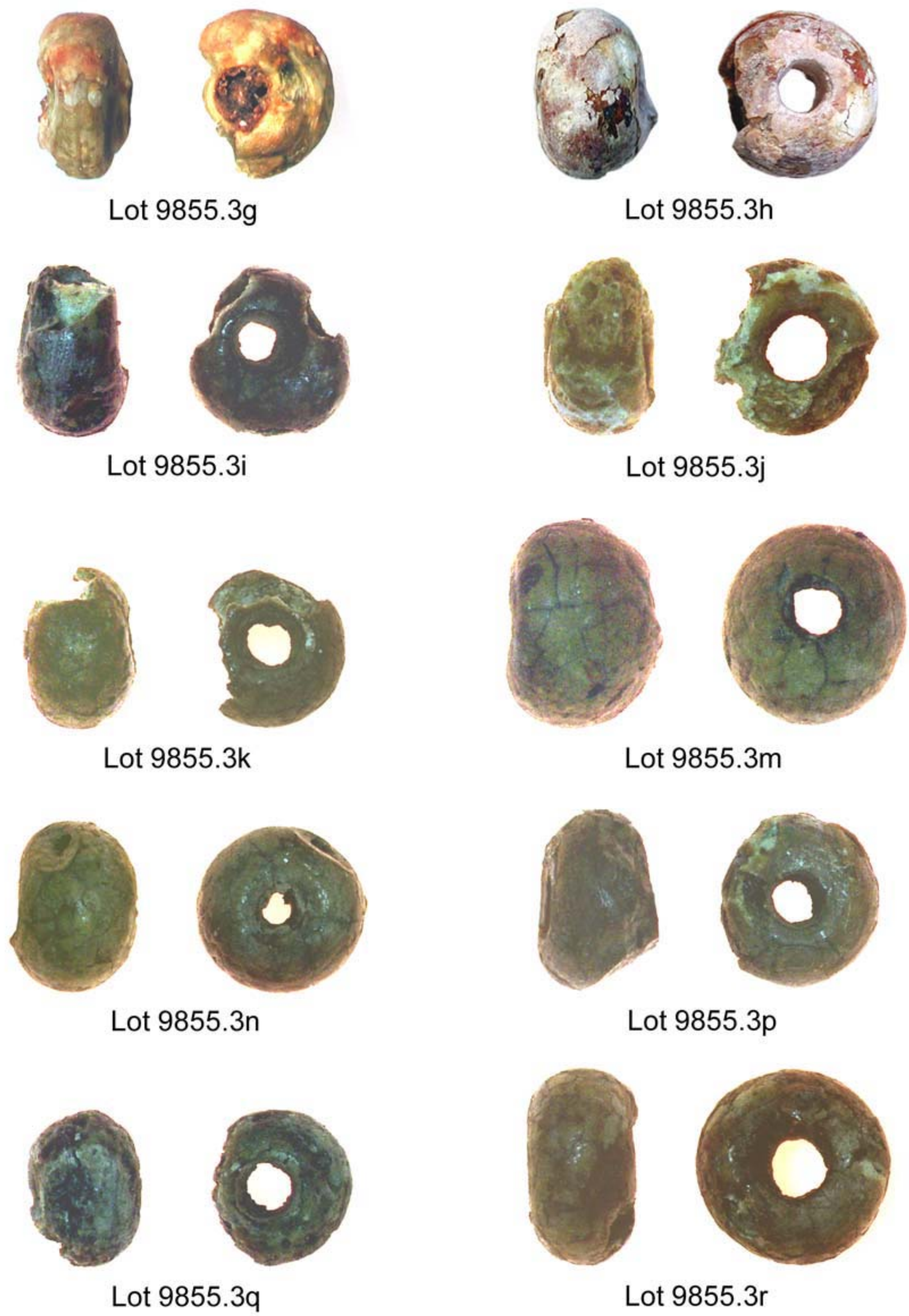

Fig. B.40. Large glass beads Lot 9855.3g - Lot 9855.3r. Scale 2:1.

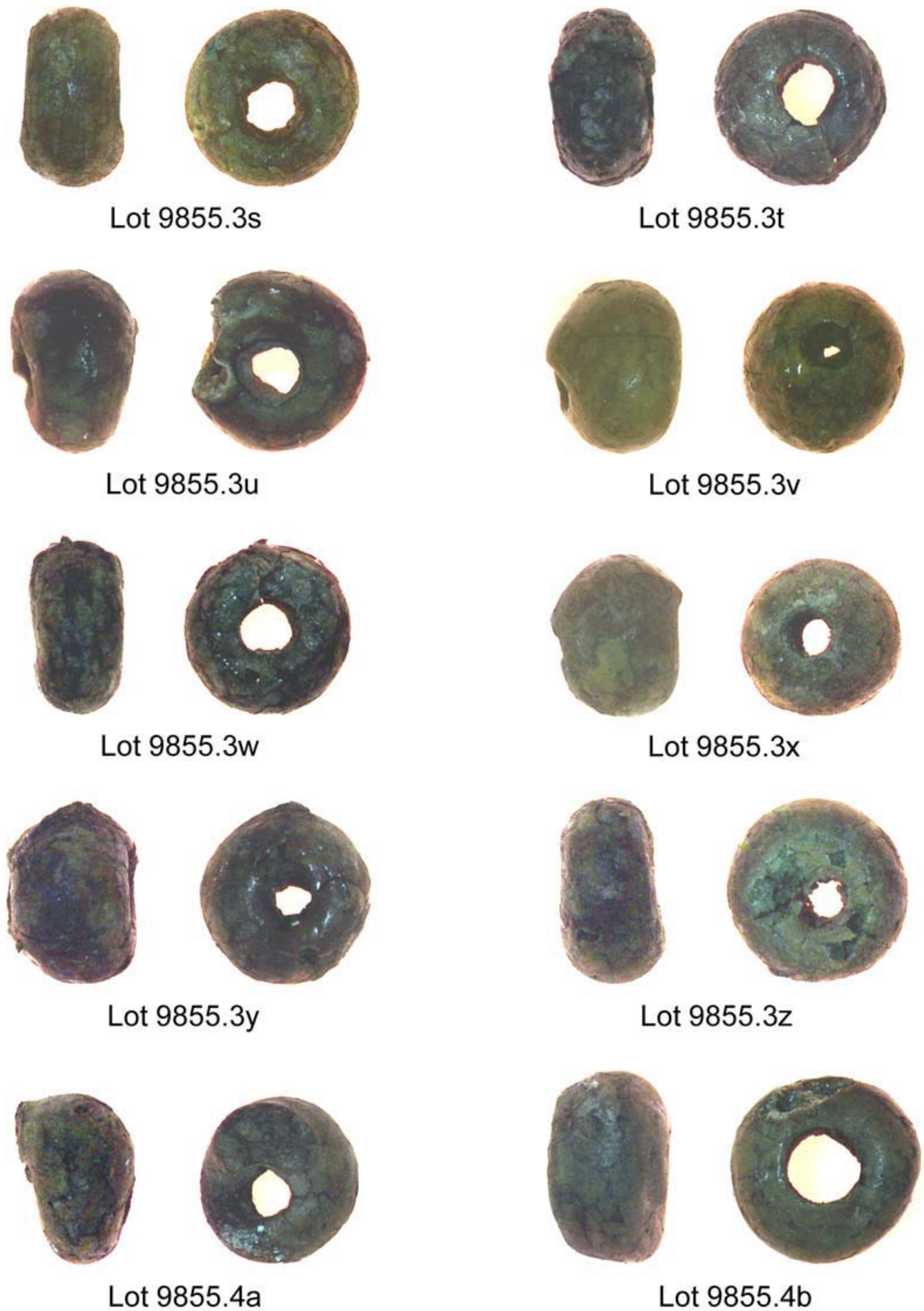

Fig. B.41. Large glass beads Lot 9855.3s - Lot 9855.4b. Scale 2:1.

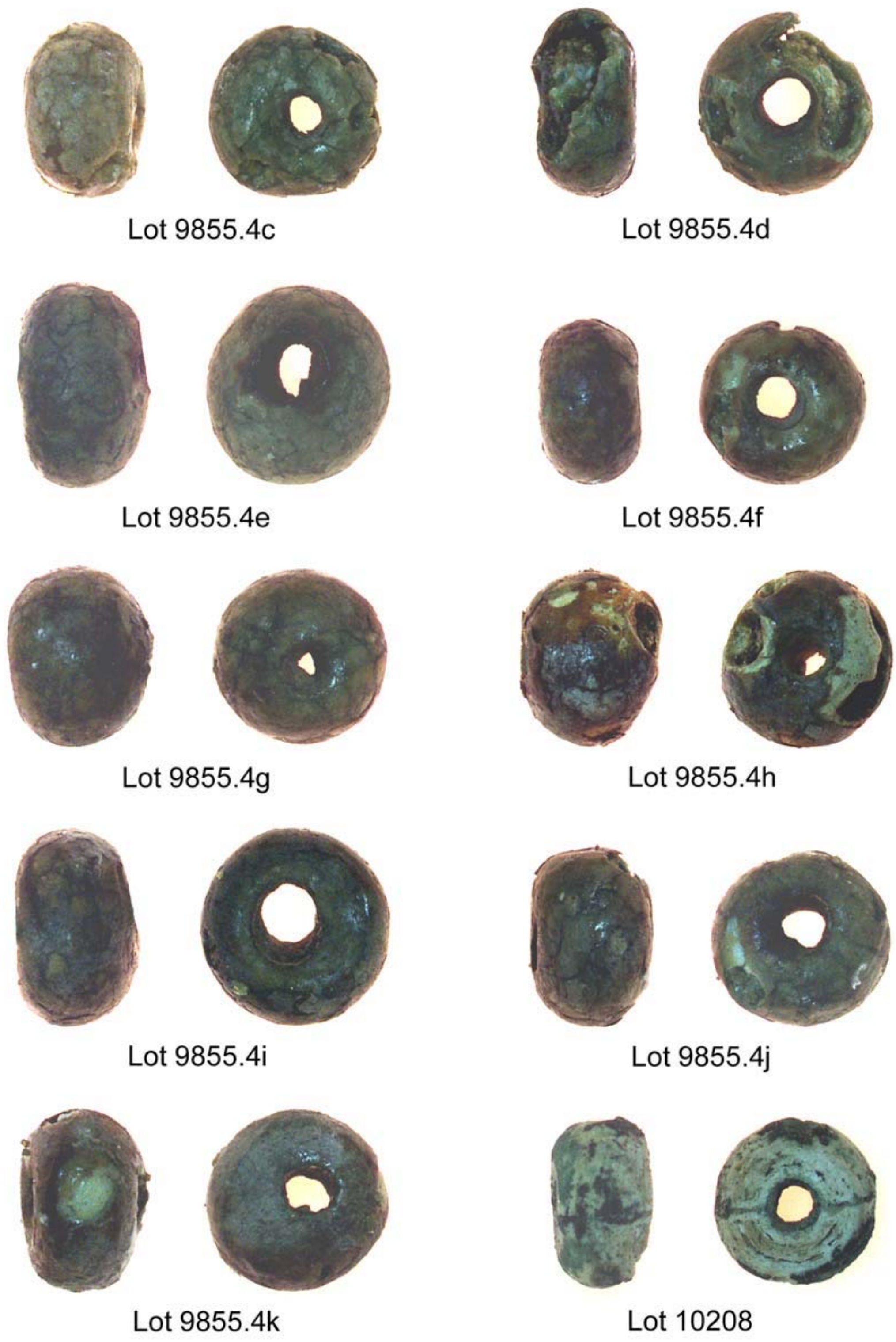

Fig. B.42. Large glass beads Lot 9855.4c - Lot 10208. Scale 2:1.

APPENDIX C

ESTIMATES OF BEADS IN CONCRETED MASSES

Concreted Mass of Tiny Faience Beads KW 76

Table C.1. Dimensions of 30 sample tiny faience beads from KW 76. All measurements are provided in centimeters.

Diameter	Length	Diameter	Length	Diameter	Length
0.21	0.13	0.30	0.13	0.25	0.16
0.27	0.14	0.26	0.13	0.26	0.11
0.30	0.13	0.25	0.12	0.25	0.12
0.27	0.10	0.28	0.10	0.26	0.14
0.26	0.14	0.28	0.13	0.29	0.12
0.24	0.14	0.26	0.13	0.29	0.15
0.27	0.15	0.31	0.12	0.31	0.16
0.23	0.13	0.30	0.15	0.23	0.15
0.21	0.17	0.26	0.14	0.29	0.13
0.23	0.13	0.31	0.14	0.25	0.15
		Average bead dimensions:		0.27	0.13

As these beads approximate to squat cylinders, their volume may be determined with the formula

$$V=\Pi \text{ x } (\text{diameter}/2)^2 \text{ x bead length}$$

Using the sample dimensions above, the volume of an average bead in KW 76 is

$$V=\Pi \text{ x } (0.135)^2 \text{ x } 0.13$$

$$V=\Pi \text{ x } 0.018225 \text{ x } 0.13$$

$$V=0.00744 \text{ cm}^3$$

Concreted mass KW 76 approximates to a rough ellipsoid with a maximum height of 9 cm, a maximum length of 15 cm, and a maximum width of 9 cm. Its base is a flattened oval, 12x6.5 cm in maximum dimension. The volume of an ellipsoid is determined with the formula

$$V_e=(4/3) \times \Pi \times r^1 \times r^2 \times r^3$$

Using the above dimensions for KW 76, the following radii may be used in the formula:

$$V_e=(4/3) \times \Pi \times 4.5 \times 7.5 \times 4.5$$

$$V_{KW\ 76}=635.85\ cm^3$$

Using a conservative estimate that only 80% of the total volume of KW 76 is composed of tiny faience beads:

# of beads=(.8)(KW 76 volume)/volume of one bead

# of beads=(.8)(635.85)/0.0074

# of beads in concreted mass KW 76=68,741 beads

Concreted Mass of Small Glass Beads KW 8

Table C.2. Dimensions of 30 sample small glass beads from KW 8.
All measurements are provided in centimeters.

Diameter	Length	Diameter	Length	Diameter	Length
0.80	0.60	0.78	0.60	0.80	0.57
0.78	0.60	0.80	0.51	0.77	0.67
0.80	0.53	0.78	0.60	0.79	0.63
0.77	0.60	0.83	0.78	0.81	0.58
0.80	0.61	0.77	0.55	0.70	0.52
0.82	0.56	0.77	0.64	0.83	0.57
0.79	0.61	0.84	0.70	0.87	0.62
0.78	0.62	0.76	0.59	0.79	0.76
0.82	0.54	0.81	0.63	0.82	0.65
0.81	0.55	0.84	0.61	0.88	0.68
		Average bead dimensions:		0.80	0.61

As these beads approximate to spheroids, their volume may be determined with the formula

$$V=(4/3) \times \Pi \times (\text{diameter}/2)^2 \times (\text{bead length}/2)$$

Using the sample dimensions above, the volume of an average bead in KW 8 is

$$V=(4/3) \times \Pi \times (0.4)^2 \times 0.305$$

$$V=(4/3) \times \Pi \times 0.16 \times 0.305$$

$$V=0.20431\text{cm}^3$$

Concreted mass KW 8 approximates to a rough ellipsoid with a conservative height of 7 cm, a length of 30 cm, and a width of 18 cm. The volume of an ellipsoid is determined with the formula

$$V_e=(4/3) \times \Pi \times r^1 \times r^2 \times r^3$$

Using the above dimensions for KW 8, the following radii may be used in the formula:

$$V_e=(4/3) \times \Pi \times 3.5 \times 15 \times 9$$

$$V_{KW\ 8}= 1978.2\ \text{cm}^3$$

Using a conservative estimate that only 80% of the total volume of KW 8 is composed of small glass beads:

# of beads=(.8)(KW 8 volume)/volume of one bead

# of beads=(.8)(1978.2)/0.20431

# of beads in concreted mass KW 8=7,746 beads

The Canaanite jar KW 8 represents the smallest of three sizes of Canaanite jars found on the shipwreck. The average capacity of this jar size is 6.7 liters.[1] Had this jar been

[1] Pulak 1998, 201.

originally filled to capacity with small glass beads, the above formulas may again be used to determine how many beads it might have held:

$$1 \text{ liter}=1{,}000 \text{ cm}^3$$

$$\text{Capacity of small Canaanite jar}=6{,}700 \text{ cm}^3$$

Using a conservative estimate that only 80% of the total volume of the jar was composed of small glass beads:

$$\#\text{ of beads}=(.8)(\text{total jar volume})/\text{volume of one bead}$$

$$\#\text{ of beads}=(.8)(6{,}700)/0.20431$$

$$\#\text{ of beads in filled Canaanite jar}=26{,}235 \text{ beads}$$

VITA

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Archaeological Fieldwork Experience:

2001-2004	Uluburun Shipwreck Research Project, Museum of Underwater Archaeology, Bodrum, Turkey. Institute of Nautical Archaeology. Research Assistant.
2001-2004	The Galley *Kadirga* Project, Istanbul Naval Museum, Istanbul, Turkey. Institute of Nautical Archaeology. Research Assistant.
2000	Tel Rehov Excavation, Beth Shean Valley, Israel. Hebrew University. Volunteer Excavator.
1995	George C. Page Museum of La Brea Discoveries, Los Angeles, California. Laboratory Volunteer.

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2000	Instructor for Graduate Records Examination Preparation Course, Kaplan Educational Services, College Station, TX.
1998-2000	Network Administrator, Biola University, La Mirada, CA.